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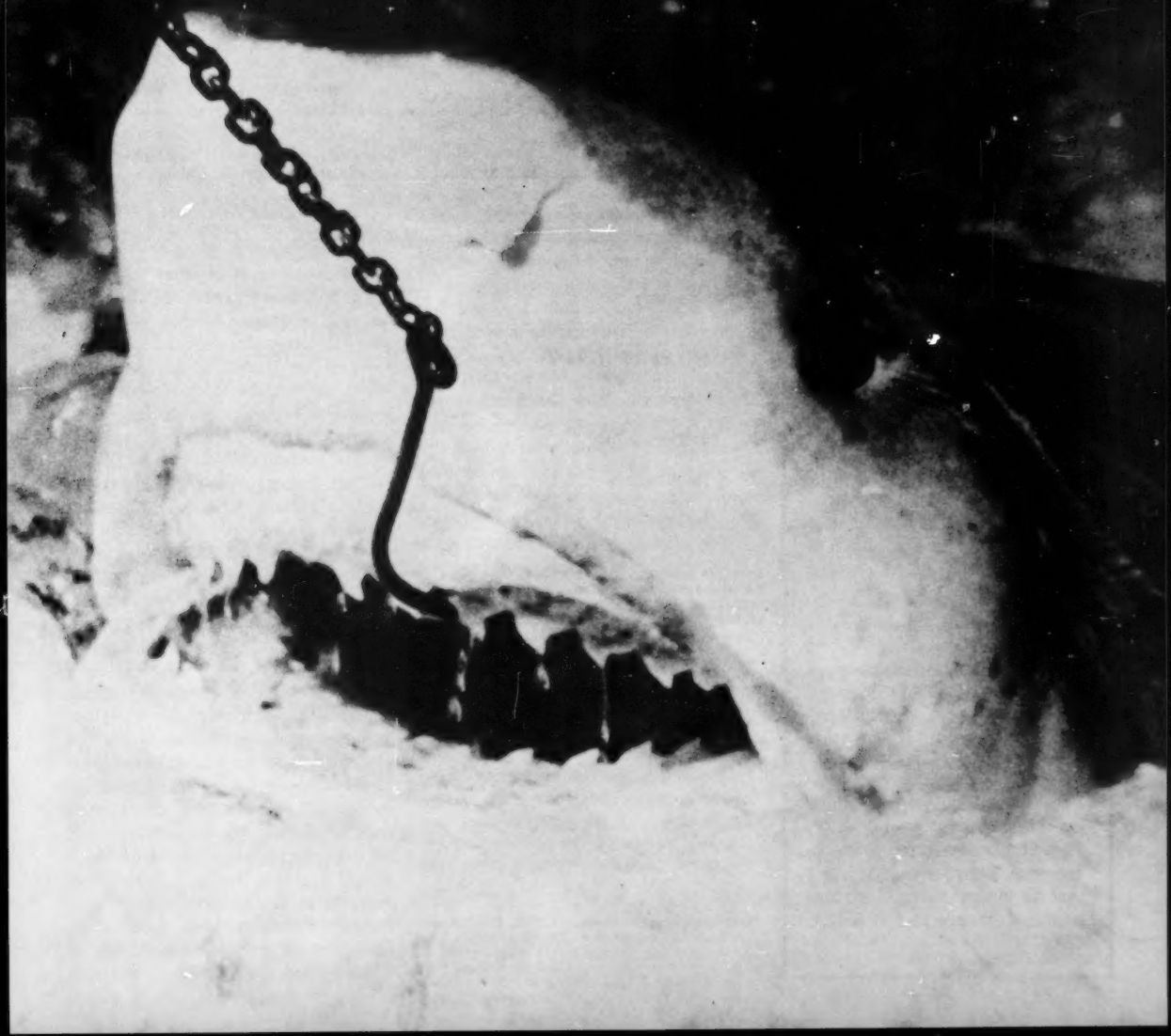

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MFR PAPER 1174

Monitoring the Ocean Environment

L. E. EBER

INTRODUCTION

Atmospheric and oceanographic conditions in the vicinity of the sea surface have historically been monitored by mariners and fishermen. From their observations has come much of our knowledge of the marine climate. Such observations, taken four times daily, recorded in weather logs and transmitted by radio to shore stations still constitute the primary source of information on surface conditions over the world ocean. This information is now supplemented by data from weather satellites which provide a major advance in global monitoring. The value of satellites for surveillance of atmospheric and oceanic conditions will increase greatly as sensor technology and processing techniques evolve.

There exists no systematic monitoring of subsurface conditions that can be considered comparable to surface monitoring. Subsurface temperatures are taken with XBT (expendable bathythermograph) systems installed on U.S. Navy vessels and on selected merchant ships which travel regular routes. Time-series data are provided by ocean station vessels (which are being withdrawn from service), and a few moored buoys and by sea-level stations at coastal and island locations. Sea-level data can give an indication of mean density in the water column in the vicinity of the station. Research vessels take subsurface observations of many kinds, but at times and places pursuant to particular objectives. Such reports must be considered as incidental to routine monitoring systems.

The basic purposes of monitoring the marine environment are to collect synoptic observations adequate for investigation of significant fluctuations in momentum and heat exchange and their effects on atmospheric and oceanic circulation, and on the distribution of relevant properties. Advances in the basic understanding of the ocean-atmosphere system have application to all activities affected by it, including transportation, military operations, harvesting and management of natural resources, recreation, etc. Particular applications may pose differing requirements upon the monitoring system with respect to time and space scales and to the properties monitored, although there are areas of overlap.

For many of these applications the existing monitoring system is considered inadequate.[1] The obvious shortcomings are the lack of surface observations outside normal shipping lanes and the general deficiency of subsurface observations, except along a few chosen tracks. Less obvious perhaps are the difficulties in making direct measurements of many important parameters and the uncertainties inherent in computing heat and momentum flux from existing observations. Not only are the semi-empirical formulas commonly used to compute these fluxes subject to question, but the actual parameter values used in the formulas (cloud amount; wind speed; and sea, air and dew point temperature) are subject to observational error. Nevertheless, in the sociopolitical, economic, and technological framework of today, there is no meaningful alternative to the existing data collection system from ships of opportunity (i.e., vessels whose primary mission is not collection of data) for large-scale monitoring of environmental conditions.

There are, however, many ways in which this system can be modified and supplemented to improve both the distribution and quality of environmental observations. Such augmentation of environmental monitoring will tend to be selective insofar as large-scale monitoring is supported mostly by government agencies, and the determination of where, when, and what to monitor is guided by an agency's objectives or mission.

The U.S. Navy, whose ships and shore stations contribute to the basic system, also supports supplementary monitoring from ships of opportunity to meet its needs for surface and subsurface data from areas not well covered by the basic system. It operates in both a direct mode, maintaining its own liaison with cooperating ships, and also indirectly through cooperation with marine-oriented academic institutions and with other government agencies, including the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS).

Academic institutions undertake the solution of a broad range of problems formulated to advance understanding of the ocean and atmosphere. They contribute directly to environmental monitoring through the activities of research vessels. They also contribute to the planning and improving of monitoring systems through investigation of space and time scales relevant to significant processes and events, development of instrumentation and methods of measurement suitable for large-scale monitoring, and through organization of observational programs needed to fill gaps in existing systems.

Weather satellites provide full global coverage of weather systems, over

[1]The status of oceanographic monitoring efforts and a specification of needs for expansion are detailed in a recent report entitled "The ocean's role in climate prediction," available from the Ocean Affairs Board of the National Academy of Sciences, Washington, D.C.

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Figure 1.—Environmental data received over National Weather Service teletype circuits are recorded on paper tape, transferred to punched cards, and inspected for quality control. The cards are then used to update environmental data files on disk for computer processing.

periods of about 12 hours, and partial coverage of surface conditions depending on cloud distribution. The National Environmental Satellite Service of NOAA, which operates this system, is primarily concerned with the sensing, reduction, and presentation of data, and has put much effort into analysis and interpretation of satellite data to facilitate user application.

In general, then, agencies and institutions draw selectively from the conglomerate environmental monitoring system according to their requirements and contribute to the total system by implementing subsystems, either on a unilateral or cooperative basis, to bolster weaknesses in particular mission-related areas. The primary purpose of this review is to describe some of the activities at the Southwest Fisheries Center (SWFC) which fall within that context. First, however, we will touch briefly upon a few of the attributes which might be considered desirable in an optimum monitoring system.

THE IDEAL SYSTEM

If sociopolitical, economic, and technological constraints are ignored, we can envisage the establishment of a World Ocean and Atmospheric Agency (WOAA) with effective capability for global monitoring. The WOAA could establish centers for collection, reduction, and analysis of all environmental data. The processed data could be loaded into a real-time data base accessible to user agencies and institutions through a time-sharing network. The real-time data base could be updated at intervals pertinent to the events or conditions being monitored. Data displaced from the real-time data base would be added to an historical data base in order to update time series and long-term means.

User agencies could select, manipulate, and further analyze data from either the real-time or historical data bases and, if appropriate, store results back into the system to be available to other users in the network. For example, generalized weather forecasts prepared by a world or national meteorological center might be retrieved, through the time-sharing network, at some particular service agency's center and tailored to the needs of that agency's constituency.

Consider the application of this conceptually ideal monitoring system toward achievement of efficient harvesting of living marine resources and effective resource management. The environment relates to these objectives in several ways. Thermal conditions, for example, establish the territorial range which particular species inhabit, and therefore delineate the fishing grounds. In temperate and colder zones, thermal conditions may have large seasonal variations which influence migration patterns and therefore delimit the fishing season. Deviations from normal environmental conditions affect the survival (abundance) and migration behavior (availability) of fish. Prognostic information on long-term trends in environmental conditions and on anomalous year-to-year fluctuations could be applied in planning and policy decisions by producers, processors, and resource managers. Analyses and short-term prognoses have application for tactical and operational decisions.

Oceanographic analyses applicable to fishing operations might include surface temperature and salinity, surface currents, location of surface convergence and divergence lines, subsurface thermal and salinity structure, and subsurface current structure.

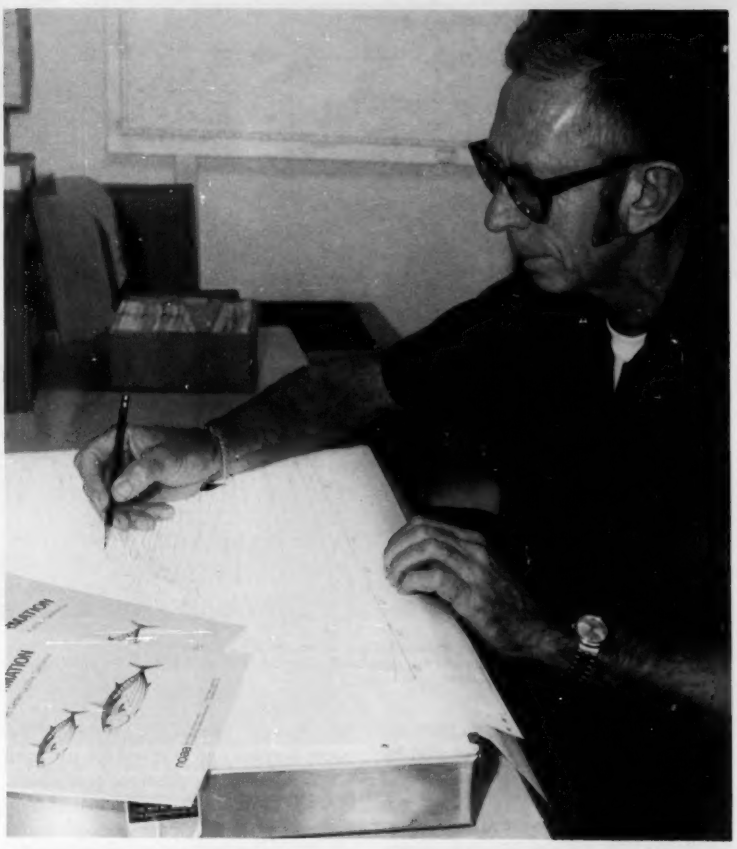

Figure 2.—Sea surface temperature data application are edited, summarized, and plotted by computer. The final analysis of isotherms is drawn by hand. Such maps appear monthly in the publication *Fishing Information*.

For planning and management applications which do not require environmental information on a real-time basis, analyses of oceanic properties could be prepared for time spans associated with significant changes in a fishery during or between seasons. The selection of properties or fields to be analyzed could be based on either established or potential information value. Particular analyses with wide application might be loaded into a special products data-base in the time-sharing network and made available to nonagency users, fishery-related or otherwise.

Environmental research to advance basic understanding of processes and to develop applications could provide feedback into the monitoring system through refinement of the specification of time and space scales for observational networks, the properties to be measured and the observing techniques.

In summary, the principal elements of the idealized environmental information system are:

1) Capability for global monitoring of oceanic and atmospheric properties, circulations, and energy and momentum fluxes on time and space scales commensurate with significant fluctuations and events in the ocean-atmosphere system.

2) Global collection and data reduction and archival facilities in which historical and current environmental data bases would be maintained and made accessible to user agencies and institutions in a time-sharing network.

3) Partitioning of basic analysis and forecast responsibilities among user agencies according to their respective missions or objectives. Adaptation of basic outputs by other agencies to satisfy particular constituency requirements.

4) Global radio and satellite communications capability for coordinated transmission of environmental information products to ships at sea and remote land stations.

5) Provision for an environmental information products file in the time-sharing system for users with requirements for immediate access to the information.

6) Provision for timely preparation and dissemination by mail of time-averaged analysis and other products not in immediate demand.

7) Ongoing research to advance understanding of basic processes in the ocean-atmosphere system, to develop capability to predict anomalous fluctuations and, for fisheries management, to determine the effects on the fisheries of such fluctuations.

ENVIRONMENTAL MONITORING ACTIVITIES AT THE SOUTHWEST FISHERIES CENTER

Three principal activities concerned with contribution to and application of environmental monitoring which have been developed at the Southwest Fisheries Center (SWFC) are: 1) the radio facsimile (FAX) advisory program, 2) the publication of *Fishing Information*, and 3) the expendable bathythermograph (XBT) ship-of-opportunity program.

FAX Program

The FAX program evolved out of the need to supplement the existing environmental monitoring effort in the eastern tropical Pacific. Recognition of this need was stimulated by EASTROPAC, an international cooperative investigation of the eastern tropical Pacific, which was intended to produce information necessary for a more effective use of the marine resources of that area, especially tropical tunas. It was apparent that biological and physical properties alike were subject to significant spatial and temporal variations. It was also apparent that the tropical tuna fishing fleet afforded the best opportunity for obtaining environmental observations in the tuna habitat.

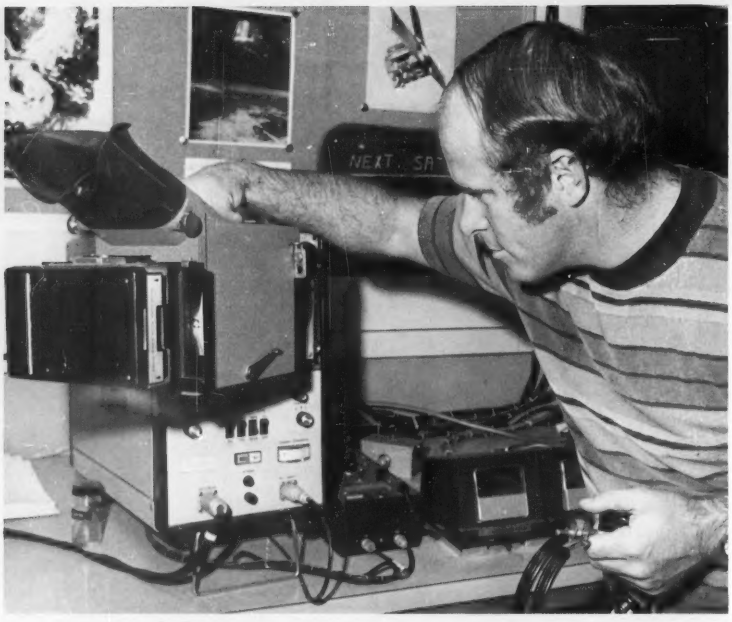

Figure 3.—Observations of cloud cover and weather phenomena transmitted from NOAA weather satellites can be received directly at the Southwest Fisheries Center. Application of satellite data to monitor ocean surface conditions is under development.

The NMFS's need for data from the eastern tropical Pacific was shared by the U.S. Navy's Fleet Numerical Weather Central (FNWC). Environmental data are used by FNWC to prepare analyses and forecasts of oceanic and atmospheric fields in support of U.S. Navy operations. Consequently, FNWC requires this data on a real-time basis.

The NMFS and FNWC recognized their mutual interest in enlisting the cooperation of fishermen for collection and transmission of observational data. They also recognized both an obstacle in securing such cooperation—that being a disinclination of tuna vessel captains to reveal their position on the fishing grounds—and a need to provide the fishermen with some incentive to take and transmit observations. The obstacle was removed through innovation of an encoding scheme for transmitting data messages which assured skippers of confidentiality with respect to their position. The incentive was provided in the form of wind, weather, and sea-state advisory charts, prepared especially for the area of the tropical tuna fishery and transmitted by radio facsimile from NMFS-licensed radio station WWD.

To implement the program, facsimile recorders were procured from government surplus and adapted for use with shipboard communications equipment. These recorders have been installed on more than 55 participating vessels under a reciprocal agreement providing for daily data transmissions from the fishing grounds. In addition, there are approximately 20 vessels in the program with privately owned units. Each vessel is furnished with its own unique encoding chart prepared at FNWC. The decoding keys are locked into the Navy computer, accessible only to the program which processes the observational messages. All participating vessels are expected to take and transmit surface weather observations, including wind speed and direction, weather, cloud cover, barometric pressure, air temperature, sea-surface temperature, swell direction, and wave height. Some 20-25 vessels in the tropical tuna fleet are equipped with XBT systems and report subsurface temperatures in the BATHY message format. The BATHY messages include temperatures and depths at significant points down to 500 meters, extracted from XBT analog traces. Maintenance of the XBT and FAX equipment is performed by SWFC personnel.

In practice, tuna vessels at sea begin transmission of weather and BATHY messages to station WWD each day about midafternoon. The messages are relayed via teletype line to SWFC and accumulated on a magnetic tape loop in the collect and transmit terminal unit of the Navy Environmental Data Network tie-line. At scheduled times, messages accumulated on the magnetic tape are sent over the tie-line to the computer at FNWC, decoded and processed for input to the FNWC operational programs. The decoded messages, along with other reports from the eastern tropical Pacific region, are sent back over the FNWC tie-line to SWFC and also to the NWS forecast office at Redwood City, Calif.

Data originating from tuna vessels, received at SWFC from FNWC, are punched on cards to be added to the environmental data base. Wind and sea-state parameters are extracted from these data and plotted on the current working charts used in preparation of the FAX advisories. Synoptic marine reports from merchant ships received over NWS meteorological teletype circuits also are used for this purpose, along with analyses and forecasts received over the NWS facsimile line and the FNWC tie-line and satellite pictures from NWS facsimile and from the SWFC direct readout system.

The weather advisory charts developed by the FAX program at the SWFC consist of a wind and weather forecast and a sea-state forecast. Prior to August 1974, these charts were transmitted from station WWD daily except Saturday and Sunday at about 4:15 p.m. The format and content of the SWFC FAX charts evolved through feedback from the fishermen. In addition to forecast wind speeds and directions, they depict the configuration of the Inter-Tropical Convergence Zone (ITCZ) and the locations of incipient tropical storms, which tend to develop along it. Such storms can intensify suddenly and pose a hazard to tuna boats which tend to fish in or near the ITCZ, trying to avoid strong prevailing winds outside but also wary of disturbances inside.

The National Weather Service (NWS) became a participant in the program in June 1974. A data line was established from the NWS forecast office, Redwood City, Calif., to radio station

WWD and to the SWFC, La Jolla, Calif., to be used for transmission of wind and weather and sea-state forecast charts prepared by NWS. Initially, the NWS charts were broadcast from WWD to the tuna fleet on weekends, to fill the gap in the SWFC transmissions, and recorded weekdays at the SWFC for evaluation and assessment of compatibility in format and in depiction of significant forecast elements.

Since August 1974, the NWS FAX charts have been broadcast from WWD daily. Surveillance of wind and weather conditions in the eastern tropical Pacific has been continued at SWFC, however, to insure that supplementary verbal advisories are broadcast from station WWD when appropriate, and to respond to direct requests from tuna vessels for information in specific situations.

In addition to the daily wind, weather, and sea state FAX advisories, three charts depicting ocean conditions are prepared at SWFC and transmitted by radio facsimile weekly. These are a sea-surface temperature analysis, a mixed layer depth analysis, and a sea-surface temperature difference chart which compares present conditions with those in the corresponding week of the previous year.

The success of the FAX program depends on continuing participation of a large number of tuna vessel owners and captains. The importance of taking observations, encoding them properly, and transmitting the radio messages must be stressed repeatedly. On the other hand, dialogue with the fishermen is also necessary to modify and adapt the advisory products as nearly as possible to their needs.

The weather logs and XBT records kept aboard the tuna vessels are collected by SWFC personnel when the vessels return to San Diego. Data taken on the fishing grounds but not received through the real-time transmission system are extracted from the logs and added to the environmental data base.

Fishing Information

Charts of sea-surface temperature (SST) for the eastern north Pacific were published by the Honolulu Laboratory of NMFS (then the Bureau of Commercial Fisheries, BCF) from 1957 through 1959 in connection with a study of the distribution of north Pacific albacore.

Figure 4.—Facsimile charts sent via land line from the San Francisco Weather Service Forecast Office are received simultaneously at the Southwest Fisheries Center and at radio station WWD, where they are recorded on magnetic tape. Visual inspection is made prior to transmission time for quality control.

Responsibility for preparation of the charts was assumed by the BCF Tuna Forecasting Program, San Diego, Calif. in 1960, in order to provide up-to-date SST information to the tuna fishing industry, governmental fishery agencies, marine scientists, and meteorologists (Johnson, Flittner, and Cline, 1965). This program also undertook the compilation and publication of historical SST data back to 1947, in furtherance of studies on tuna environment (Johnson, 1961; Renner, 1963).

Initially, the SST charts were issued monthly for the region north of lat. 20°N and east of long. 180° and, during the albacore fishing season, semimonthly for the region of lat. 25° to 52°N and east of long. 136°W. Monthly SST plots for 1-degree squares were prepared for the eastern tropical Pacific between lat. 20° N and 20°S. The computation of the monthly and semimonthly mean temperature values, and the plotting of these values on base maps for analyses of the temperature fields, were done by hand. As emphasis shifted to automatic data processing and feedback from users identified additional needs for environmental information, the analyses were extended to include other regions and other properties.

Fishing Information now contains the following monthly charts: a) Sea surface temperature for the eastern north Pacific; b) Sea surface temperature for the western north Pacific; c) Sea surface temperature for the eastern tropical Pacific; d) Deviations from long-term means of a), b), and c); e) Difference between a) and the corresponding SST field one year earlier; f) Sea level pressure and resultant wind (both current month and long-term monthly means) for the eastern north Pacific.

Fishing Information also contains graphs of subsurface temperature structure along ships' routes from Hawaii to U.S. west coast ports, narrative descriptions of the significant features of the charts, and articles on the albacore fishery at the beginning and end of the albacore fishing season.

The semimonthly SST charts are now published year-round as the *Fishing Information* supplement. During the albacore fishing season, they are accompanied by the *Albacore Bulletin* which contains timely information on fishing conditions and on the progress of the fishery.

In addition to the charts listed above, a set of tabulations is produced each month which contains average SST's, air temperatures, dew point temperatures, sea level pressures, cloud amounts, and resultant winds for 5-degree squares. From these monthly averages of observed environmental variables are computed the principal components of heat exchange at the sea surface, including incoming radiation, reflection, back-radiation, evaporation, and sensible heat flux. The tabulations also contain deviations of each of the observed and computed variables from their respective long-term monthly means. These monthly tabulations are not routinely distributed, but are available for on-site use by local users. Also, a preliminary run of the 5-degree averages is made a few days before the end of each month for use by the Long Range Prediction Group of the National Weather Service. Cooperation with other organizations in this way offers potential benefit through progress in understanding and prediction of large-scale environmental fluctuations.

The computation of heat exchange components from monthly averages of observed environmental variables gives relatively gross estimates of heat flux across the sea surface. Although there have been attempts to use such estimates in oceanic heat budget studies, their value for monitoring significant fluctuations has not been fully evaluated. To make the information more widely available, an 11-year series (1961-1971) of total monthly heat exchange has been compiled in chart form for the eastern north Pacific, and published along with monthly mean charts of each of the principal components averaged over the same period (Clark et al., 1974).

The principal source of data for the environmental charts prepared by the SWFC, other than reports from tuna vessels, are the 6-hourly synoptic ship's weather observations transmitted from ships at sea in the International Ship's Meteorological Code and collected by NWS. The system developed by the Tuna Forecasting Program in 1960 for processing the observations employed a computer program which produced printed SST summaries and other parameters at the end of each month. The summary values were hand plotted

Figure 5.—Advisory charts prepared for radio facsimile transmission are displayed for convenient reference along with environmental charts and satellite pictures received from the National Weather Service, and Fleet Numerical Weather Central.

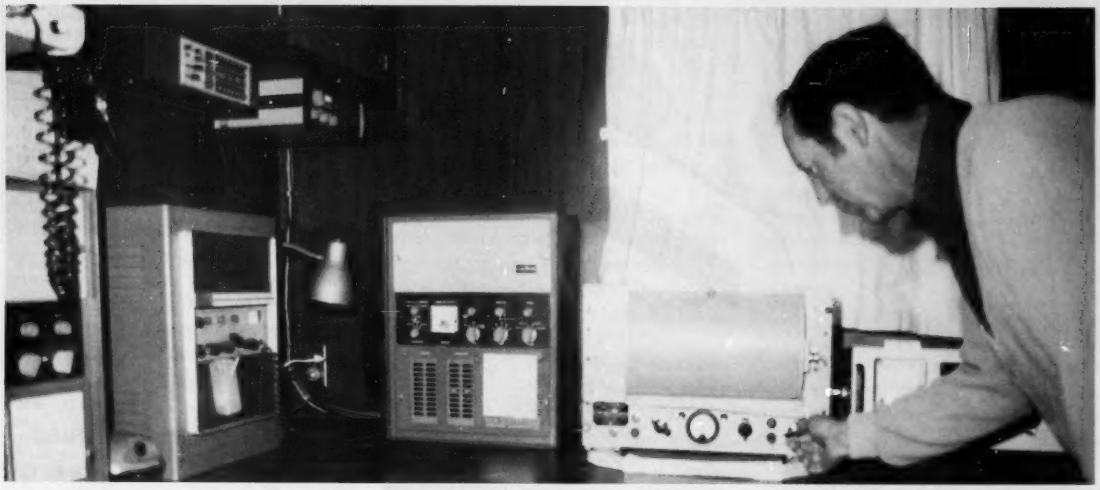

Figure 6.—Weather advisory charts can be received daily by fishing vessels such as this one equipped with radio facsimile recorders. Observational data received from the fishing vessels contribute significantly to the accuracy of the advisories.

and analyzed to prepare the environmental charts for *Fishing Information*. The original observations were saved on punched cards.

Subsequently, programs were added or modified to produce new outputs such as digital plots to replace those formerly done by hand, and special printouts formatted in a geographical grid for convenient reference. The present system provides for frequent update and ready accessibility of both current and past data on disk and magnetic tape files so that operational programs can be run on schedule and special analyses or plots for any time period and any specified region can be run as required.

Ship-of-Opportunity Program

This program was initiated to expedite utilization of a new instrument system (the XBT) capable of augmenting subsurface temperature monitoring and to apply the new system to create time series of subsurface temperature data along well-frequented shipping routes (Saur and Stevens, 1972). Such data are needed for the identification, quantitative description, and understanding of seasonal and nonseasonal changes in the subsurface temperature structure and heat content and of mass transports (through geostrophic estimation of currents) in the upper layers of the tropical and northeast Pacific Ocean. The program activities comprise three phases: 1) Data collection, in which observations of surface salinity and of vertical temperature profiles are made at 120-170 km intervals with expendable bathythermograph instrumentation aboard ships of opportunity; 2) Data processing, in which the observations are digitized, edited, printed for convenient reference, and added to the XBT data base for research; and 3) Data analysis, in which temperature-depth sections are prepared and the observations are analyzed to depict changes in subsurface ocean conditions.

The ship-of-opportunity program started in 1966 with a single ship, the Matson Navigation Company's bulk sugar carrier *Californian*, which made about two trips per month on the San Francisco-Hawaii run. The present program is considerably larger and, in 1974, involved three shipping companies and nine different ships.[2] During that year the program produced 52 sections between San Francisco and Hawaii, 27 sections between Los Angeles and Hawaii, 10 sections between Seattle and Hawaii, 2 sections between Alaska and Hawaii, 4 sections between Tahiti and Hawaii, and 4 sections between Samoa and Hawaii.

The program is conducted jointly with the NMFS Pacific Environmental Group, Monterey, Calif., where the digitization and computer analysis of subsurface temperature structures is performed and through which liaison with cooperating ships is supervised. Responsibility for the data analysis was transferred from SWFC to the Scripps Institution of Oceanography (project NORPAX) at the end of 1974. The program interfaces with FNWC interests in global monitoring of subsurface temperature on a real-time basis and with academic interests in understanding the processes of air-sea interaction and fluctuations in oceanic heat storage. The program receives support from FNWC, in the form of computer time and expendable probes, and from the National Science Foundation and the Office of Naval Research through project funding.

FNWC has supported the installation of XBT systems on merchant, fishing, and research vessels to supplement those on naval ships in order to obtain broad geographical coverage with sampling intervals sufficient to resolve large-scale oceanic features. For definition of mesoscale eddies, which have come under recent investigation by oceanographers and may be important in connection with transient ocean fronts, much finer sampling is required. Such sampling can be carried out from merchant ships only when project observers are aboard. The NMFS program has endeavored to maintain an intermediate sampling interval sufficient to identify transition zone characteristics between water masses and to reveal significant fluctuations along repeated tracks.

[2]Matson Navigation Company, Chevron Shipping Company, and Pacific Far East Line. Mention of trade names, commercial products, or firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 7.—Some fishing vessels are equipped with expendable bathythermograph systems. Temperature-sensing probes, released from a hand-held launcher, send data back to the vessel through fine conductor wires as they descend through the water.

Ancillary Information Sources

In establishing capability for monitoring environmental conditions of concern to fisheries, SWFC has become an acquisition center for real-time environmental information in a variety of forms. Analyses and forecasts of subsurface, surface, and upper air conditions are received daily over the FNWC tie-line and plotted as charts on CalComp plotters. A similar array of products is received over the NWS facsimile circuit. The NWS circuit also carries gridded satellite pictures from polar-orbiting and geostationary weather satellites. These pictures are particularly useful in determining the location and configuration of the ITCZ and in following the development of tropical storms. SWFC also can receive pictures transmitted directly from the polar-orbiting satellites on nearby orbits which occur twice each day. The satellite pictures, oceanographic and meteorological analyses, and forecast charts are displayed on the chart board in the environmental data room for convenient reference by environmental analysts, other SWFC staff, and visitors. The daily proximity of current environmental charts helps the analyst become attuned to the time and space scales of real-time events and develop insights which can lead to new approaches in the investigation of the ocean-atmosphere system.

Weather satellites have great potential for ocean monitoring, and the National Environmental Satellite Service has spent considerable effort in the interpretation of data from scanning radiometer infrared sensors to determine sea-surface temperatures. Although significant problems exist, one of the foremost being cloud contamination, this effort appears certain to lead to useful application, and growing consideration has been give to ways of incorporating this information into the routine SST analyses. The SWFC has cooperated with the Inter-American Tropical Tuna Commission, through use of the direct readout satellite receiving system, in studies to evaluate the feasibility of using data from scanning radiometer sensors aboard NOAA satellites to discern oceanic fronts and to apply satellite data to problems of fishery oceanography (Stevenson and Miller, 1974).

APPLICATION TO FISHERIES

The purposes underlying SWFC's involvement in environmental monitoring, through the programs described in the preceding section, are to contribute to the development of the real-time fishery prediction capability and effective resource management. A fishery prediction and management system should accomplish two basic functions: 1) Help maintain the fishery at a level of abundance consistent with optimum yield and recoverability from adverse environmental conditions or excessive fishing pressure; and 2) Increase the efficiency of harvesting, through prediction of distribution and availability, in order to maintain a viable fishery that can deliver fishery products to the consumer at an economical and competitive price. By strengthening the total environmental monitoring effort in areas which are important to fisheries, the potential benefit of research in relationships between the environment and fisheries is enhanced.

Environmental data taken by tropical tuna fishermen on the fishing grounds in the eastern tropical Pacific during 1971-1974, as a direct result of the FAX program, are shown in Table 1. These data are being utilized in ongoing research on the relationship between environmental parameters and fishing success.

The FAX program contributes to the efficiency of harvesting by meeting the needs of tropical tuna fishermen for information on weather and ocean conditions. Interviews with 22 skippers and navigators were conducted between December 1973 and March 1974 to obtain the fishermen's evaluation of the

Table 1.—Summary of marine observations, 1971-1974.

Year	Weather	BATHY	Total observations	Boats
Collected by radio station WWD				
1971	[1]844	684	1,528	3-25
1972	2,150	498	2,648	39-53
1973	2,579	570	3,149	55-57
1974	2,178	408	2,586	61-63
Total	7,751	2,160	9,911	
Collected from weather and BATHY logs				
1971	—[2]	886	—[2]	3-25
1972	2,610	665	3,275	39-53
1973	5,167	1,160	6,237	55-57
[3]1974	3,265	616	3,881	61-63
Total	11,042	3,327	14,369	

[1]WWD did not collect weather observations on a regular basis until September of 1971.
[2]Weather observations from fishing vessels were integrated into the monthly deck of synoptic observations and not separately accounted for.
[3]1974 figures are based on projections pending receipt of all of the 1974 data.

FAX products. Nearly all of those interviewed indicated that they copied the FAX charts every day, if possible, and listened to the verbal advisories broadcast on weekends when severe wind or weather conditions were expected.

The information regarded as most valuable is the location and expected movements of chubascos (tropical storms) and of extreme wind conditions such as occur in the Gulf of Tehuantepec. Sea and swell advisories and the sea surface temperature charts were rated next in value for aid in deciding when and where to fish. The mixed layer depth charts are being copied by most of the vessels, judging from the sample response, but were given a high value rating in only a few cases. These charts represent an effort to furnish environmental information to the fisherman on a provisional basis and thereby enlist his participation in developing the potential application of such information to fishing strategy. The charts also form a time series depicting weekly changes in oceanographic features, which may induce short-term variations in fish behavior and distribution.

The FAX program also provides a service to the albacore fishery through weekly transmission of sea surface temperature charts covering the albacore fishing grounds. This activity contributes to the joint research effort of the SWFC Albacore Research Investigation and the American Fishermen's Research Foundation (AFRF). These charts are copied by about a dozen vessels equipped with FAX recorders by AFRF. As with the tropical charts, they provide the fisherman with environmental information applicable to fishing strategy, and also support the work of the albacore investigations in modeling the albacore fishery.

The series of monthly and semimonthly charts of sea surface temperature and other environmental fields, published in *Fishing Information* and its *Supplement*, go back as far as 1960. They are sent to a distribution list of some 1,196 individuals, organizations, institutions, and agencies, some of whom receive copies for further distribution. In order to assess the impact and utilization of these charts, recipients were asked to fill out and return a brief questionnaire distributed with the November 1973 issue. A total of 575 questionnaires were returned. They reveal the following breakdown by user classification:

User classification	Percent of total returns
Commercial fishermen	38
Processors and distributors	3
Sport fishermen	9
Fishery managers	10
Marine scientists	16
Teachers	10
Other	14

The last category includes meteorologists, military oceanographers, marine suppliers, librarians, trade journal publishers, and others. The survey revealed that the charts are used primarily for fishing strategy by commercial and sport fishermen, for planning by processors, for fishery research by fishery managers, and for environmental research and teaching by marine scientists, meteorologists, and educators. The survey indicated greatest interest in the SST charts for the eastern north Pacific; however, all of the environmental charts received favorable response.

Overall, the response to the questionnaire affirms that the program is accomplishing its original objectives. It benefits the industry by providing useful environmental information and contributes to potential advances in fishery prediction by benefiting environmental and fishery research. It should be noted that the preparation and distribution of environmental charts by this program is a unique undertaking, and to some degree, provides the only generally available source of quasi-current information on abnormal conditions, such as El Niño occurrences. The SWFC receives numerous inquiries during such anomalous events concerning the status and tendency of environmental conditions.

Although much work has been done on the relation of fish to environmental conditions, the problem has hardly been scratched. An intensive and long-range research effort must be sustained to determine the specific extent and nature of environmental control on the distribution, survival, and behavior of fish. A similar effort must be made to understand the forces that produce environmental fluctuations which may have significant effects on a population. Such efforts must be supported by a comprehensive monitoring of the ocean-atmosphere environment and by reliable assessments of sizes and locations of populations. Only when adequate descriptions of relevant environmental fields are available along with adequate descriptions of fish stock distribution, can the knowledge of environmental processes and of behavioral responses to such processes be applied effectively in a fishery prediction system to control the fishery.

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MFR PAPER 1175

New light is shed on shark anglers and the sport of shark fishing.

Recreational Shark Fishing on the Texas Gulf Coast: An Exploratory Study of Behavior and Attitudes

ALAN R. GRAEFE and ROBERT B. DITTON

ABSTRACT—Today there is little literature on shark fishing participation, less on its participants, and none to explain shark fishing motivations. Members of the Corpus Christi (Texas) Shark Association were interviewed in October 1974 to collect data regarding their socioeconomic characteristics, fishing participation patterns, harvest records, attitudes, and motivations. The shark fishermen studied were found to be avid fishermen who participated in many other forms of fishing besides shark fishing. Most fished from shore where catching a "keeper" (shark over 6 feet) was rare. A few individuals, however, were very successful fishing for sharks off shore. Anglers studied were found to perceive sharks with a sense of respect and admiration or in relation to the challenge of the shark fishing experience. Few shark fishermen expressed a fear or hatred of sharks. The aspect of shark fishing cited most often as the most important motivator was the challenge or sport of fishing. Other important aspects of the fishing experience cited were "being outdoors," "being with friends," "getting away from the regular routine," and "relaxation." The number and size of fish caught were reported as being less important than the other reasons cited. Shark fishermen therefore cannot be characterized as being highly motivated by harvest-related factors. Instead, they appear to derive satisfaction from the entire shark fishing experience. When shark fishermen were compared to two other samples of fishermen (Wyoming trout fishermen and New York lake and stream fishermen), all three groups showed similar motivations for fishing. This suggests that shark fishermen are not a specialty group of predator or "meat" fishermen as might be hypothesized, but rather fish for many of the same reasons as other fishermen. Implications of this exploratory effort for further research are discussed.

INTRODUCTION

Many authors in the popular literature have written about man's feelings about sharks in posing the ultimate question of why we can't rid our waters of the shark menace. Most conclude that men fear and hate sharks. Benedict (1962) asserts that most fishermen consider the shark a predaceous brute. Wiles (1962) labels the shark as one of the most diabolical inhabitants of the sea. Mackerodt (1974) seeks to reason why man fears sharks. He notes that the shark is unique in its desire to hunt man and that man is helpless in the shark's environment. The shark is perceived as an unseen threat and this triggers fear. Sugar (1974) feels there is more fascination than fear. Sharks are unknown quantities in that no one knows their population size and distribution, how long they live, nor how they die.

While it is probably true that most people fear sharks, this paper explores an aspect of the man-shark relationship that has received little attention previously in the technical literature: shark fishing. Man has long fished for sharks but only recently has the everyday sportsman turned to shark fishing. Today shark fishing is often referred to as "poor man's big game fishing," and surf fishing for sharks is becoming one of the fastest growing forms of fishing along the coast (Sand, 1972). However, there is little literature on shark fishing participation, less on its participants, and none to explain the motivations for shark fishing.

It can be reasoned that when sharks are viewed as game, the often discussed emotions of fear and hatred directed toward them are replaced by emotions like respect, challenge, and enjoyment of danger and beauty. Coran (1974), for example, views the shark as one of the few creatures whose consummate skill as a killer transports him beyond the range of evil into a special beauty. Their unpredictable nature is a part of their mystique. Benchley (1967) suggests that the shark fisherman is motivated by the dangers involved. Slaughter (Stephens and Slaughter, 1962) believes sharks are kings of the undersea jungle, and he likes to put them on the defensive and to outwit and defeat them. Hunting sharks in scuba gear and with explosive devices, Slaughter kills every shark possible. He considers shark hunting akin to big game hunting.

In addition to meeting informational needs about shark fishing and why man fishes for sharks, this research provides greater insight into the relationship between the fisherman and the fish in the environmental system. Counter to popular literature, it is hypothesized in this paper that fishermen pursue sharks for sport, rather than out of hatred, and that they enjoy the shark fishing experience whether they harvest a shark or not. The implications of these notions

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A lemon shark, 7' 8" long. Photo courtesy of the Corpus Christi Shark Association.

for fishery resource management alone are enormous. This paper further probes the hypothesis that the number of fish caught actually represents a small part of the fishing satisfaction derived (Field, 1974).

Traditionally, fishery management has focused on harvest, based largely on the assumption that harvest is the principle source of satisfaction to the sportsman. A rival hypothesis would be that fishermen are not particularly concerned with harvest but instead fish primarily for other reasons. There is considerable evidence in the literature to support this hypothesis.

Historically, fishing has been portrayed as primarily contemplative and solitary. An early article on angling (1739) placed great emphasis on its diversion capabilities (U.S. Outdoor Recreation Resources Review Commission, 1962). Also, from a limited nationwide sample of fishermen (Anonymous, 1967), *Field and Stream* concluded that the representative angler believes there is more to fishing than catching fish. Frequently mentioned attributes of fishing were liking the fresh air, getting out of the city, using homemade lures, being on the open seas, and change in routine. In a study of Ohio fishermen, 57 percent indicated their satisfaction with their fishing experiences even if they caught no fish (Addis and Erickson, 1969). Similarly, a majority of a sample of Idaho anglers indicated their preference for fewer, but larger, trout (Gordon, Chapman, and Bjornn, 1969). Moeller and Engelken (1972) suggest that elements of the natural environment—water quality, natural beauty, privacy while fishing—are more important (than harvest) to the overall enjoyment of fishing. Knopf, Driver, and Bassett (1973) suggest that fishermen are strongly motivated by four unmet needs: temporary escape, achievement, exploration, and experiencing natural settings.

This paper likewise probes fishing motivation and enjoyment and does so with what might be hypothesized as an extremely harvest-oriented group of fishermen—shark fishermen. Two particular aspects of fishermen's attitudes will be emphasized. First, how do shark fishermen perceive sharks as animals and as resources? And second, how important are the consumptive aspects of fishing, such as size and number of fish harvested in relation to the enjoyment of the fishing experience?

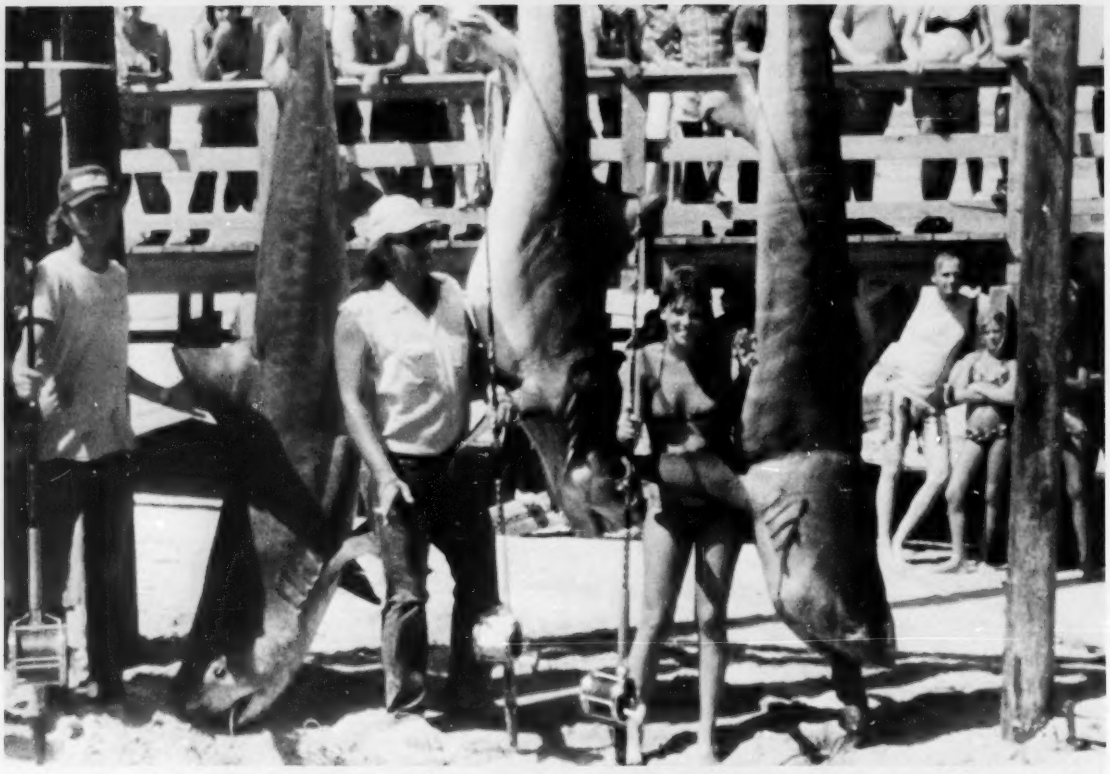
This study aims to provide basic data to further understanding of the sport of shark fishing. In addition to being the first systematic study of shark fishing and its devotees, the findings will enable comparisons with other types of fishermen.

OBJECTIVES

1) To identify socio-economic characteristics and attitudes of members of the Corpus Christi (Texas) Shark Association.

2) To gain insight into shark fishing on the Texas coast and to identify types of shark fishing that take place.

3) To serve as a preliminary study to



Tiger sharks, 11' 3", 10' 4", and 11' 3" in length. Photo courtesy of the Corpus Christi Shark Association.

test and generate new hypotheses about shark fishermen as well as to lay the foundation for a more generalizable study of shark fishermen.

4) To compare findings with existing data on other fishermen to determine whether shark fishermen differ substantially from other types of fishermen in their behavior, attitudes, and motivations.

HYPOTHESES

1) Members of the Corpus Christi Shark Association view sharks as big game. Thus, they fish for them primarily for the challenge or sport involved. In spite of this, though, they are not obsessed with catching sharks, and enjoy the fishing experience whether they catch a shark or not.

2) Members of the Corpus Christi Shark Association do not indicate that they hate sharks and are afraid of them, as most popular literature concerning sharks indicates. Rather, they respect sharks as magnificent creatures and sport fish.

STUDY POPULATION

The population studied was the entire membership of the Corpus Christi Shark Association (n = 35), a club whose members are shark fishermen. Because of the small membership size, it was determined that all association members would be interviewed if possible.

The lack of wide generalizability of study findings is recognized but it should be remembered that this was an exploratory study. This group of shark fishermen was selected primarily because it was accessible and cooperative. Neither the group nor study findings are intended to represent all shark fishermen.

METHODS

Data for this study were obtained through personal interviews in October 1974. After the structured interview schedule was prepared and pretested, interviews were conducted on two consecutive 4-day weekends with all club members available. Since the study took place after the shark fishing season (April-September) interviews were conducted individually at a time and place convenient to the respondent, generally at home. The leadership of the Shark Fishing Association was familiar with the study and encouraged the membership to cooperate fully with the interviewer.

The interview schedule included structured questions in the following general categories: basic personal information; socioeconomic characteristics, participation and catch record; techniques, equipment, and expenses; and motivations and attitudes. A few open-ended questions were put to cross-validate structured question categories.

Twenty-nine of the 35 active association members were interviewed. The remainder were unavailable on the two survey weekends. At least three call backs were attempted for each member who was not interviewed. No one refused to be interviewed.

FINDINGS AND ANALYSIS

Fishermen Characteristics

The socioeconomic characteristics of the shark fishermen summarized in Table 1 allow comparison with two other studies of fishermen. Shark fishermen are generally younger and less experienced than the other fishermen. They are typically male, and about 65 percent are married. The shark fishermen studied were better educated than the northeastern U.S. sample (83 percent high school graduates as compared with 63 percent). This, as well as the fact that fewer are married, may be related to the younger average age of the shark fishermen. All shark fishermen in the study group became interested in fishing for sharks after they had been active in other forms of angling.

Table 1.—Comparison of socioeconomic characteristics of 29 shark fishermen, a random sample of licensed fishermen in six northeastern states, and a sample of 100 New York fishermen.

	Shark fishermen	Six N.E. states[1]	New York[2]
Average age	27	40	40
Years experience	19	26	24
Male (%)	89.7	90	87
Married (%)	65.5	79	87
High school graduates (%)	83	63	

[1]Data from Bevins et al. (1968).
[2]Data from Moeller and Engelken (1972).

Shark Fishing Patterns

The shark fishermen studied can be divided into two groups based on the location of their activity, onshore and offshore. Approximately 75 percent of the study group fished most often from shore (beach, 45 percent; pier, 10 percent; and jetties, 20 percent). The remaining quarter of the population fished most often from boats offshore.

Shark fishermen indicated that they almost always fished with friends, although 14 percent of the study group had gone fishing alone. Thirty-eight percent had gone fishing with their spouse and 24 percent with members of their family, but in all instances, friends were also included in the fishing party. The average number of fishing occasions during the past 12 months for club members was 14.6 times. Since shark fishing trips sometimes involve entire weekends, and at other times take place in a day, 14.6 times probably underestimates the actual number of days spent shark fishing.

Table 2.—Shark fishermen fishing participation records for the past 12 months from 29 shark fishermen.

Area	Percent participating	Mean no. of experiences	Range
Freshwater			
Streams, brooks, creeks	6.9	0.6	0-12
Rivers	31.0	1.9	0-15
Lakes	44.8	4.9	0-35
Reservoirs	20.7	0.6	0-10
		Total 8.0	
Saltwater			
Surf, bank, jetty	72.4	10.2	0-85
Pier	72.4	13.0	0-125
Bay (party boat)	10.3	0.2	0-3
Bay (private boat)	75.9	7.0	0-50
Gulf (charter boat)	24.1	0.6	0-7
Gulf (private boat)	51.7	2.0	0-15
		Total 33.0	
		Shark fishing total 14.6	
		Total fishing participation 55.6	

Table 2 summarizes the study group's total fishing participation record for the past 12 months. It is clear that, in addition to shark fishing, club members participate in a variety of fishing activities. They averaged 8 times at freshwater locations and 33 at saltwater locations, excluding shark fishing. Thus, the average total fishing participation is 55.6 times during the past 12 months.

It is useful to compare this participation data with information concerning the fishing behavior of the national population. In 1970, for example, 29.4 percent of the total population went fishing an average of 11.4 days (U.S. Department of the Interior, 1972). Therefore, it appears that the present study group is composed of extremely avid fishermen.

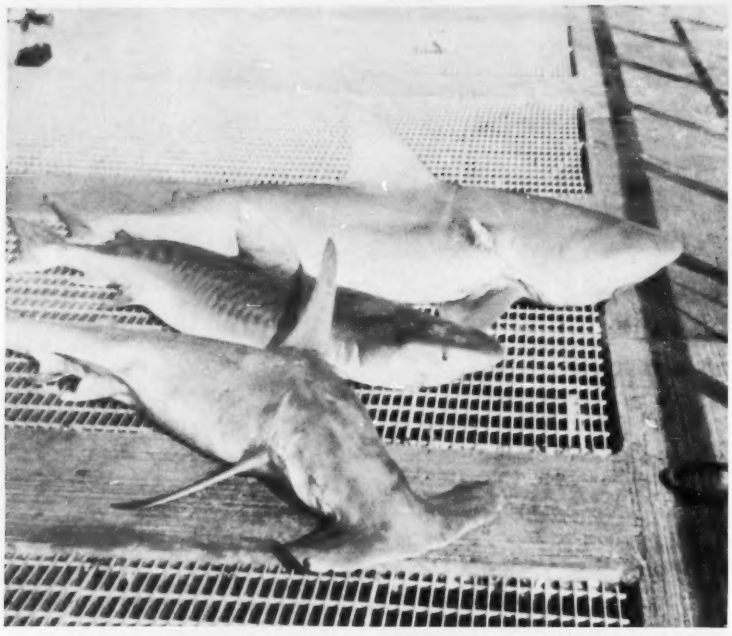
Table 3 reports the shark catch record for club members. It is immediately striking that slightly over one-half of the study group harvested no sharks last season and also that three individuals caught more than half of the total number of sharks harvested. A few words of explanation are in order concerning the recording of harvest. First, only sharks over 6 feet in length are considered "keepers" and are recorded. This explains why so few sharks are indicated. When sharks under 6 feet are caught they are either killed or released, depending on their condition after the fight and the angler involved. These sharks are not recorded and, thus, not included in the harvest tabulation in Table 3. Second, onshore and offshore shark fishing vary considerably with respect to fishing success. It is well established that offshore fishing yields a greater rate of harvest. In this study, the three individuals who caught the large number of sharks (13, 18, and 19, respectively) are all offshore fishermen, while those who caught few or no sharks are generally onshore anglers.

Table 3.—Shark harvest record for the past 12 months from 29 shark fishermen.

Number of shark fishermen	Sharks caught	
	No.	Total
15	0	0
2	1	2
1	2	2
4	3	12
1	4	4
1	5	5
0	6	0
2	7	14
1	13	13
1	18	18
1	19	19
Total 29		89

Attitudes And Motivations of Shark Fishermen

To assess shark species preferences of shark fishermen, each was asked the open-ended question, "What type of shark do you hope to catch?" The responses "big" or "any" were given twice as often as any particular species was named (Table 4). It appears from this that these fishermen in general are interested in catching sharks and are not particularly concerned with what species they catch.



Three sport-caught sharks: Top, bull shark, 9′ 2″ long; middle, tiger shark, 8′ long; bottom, hammerhead, 8′ 6″ long. Photo courtesy of the Corpus Christi Shark Association.

Table 4.—Responses from 29 shark fishermen to, "What type of shark do you hope to catch?"

Response	Frequency[1]
Any	10
Tiger	9
Hammerhead	9
Big	8
Aspiration: Great white	4
Depends on time of year	3
Bull	2

[1]Column not totalled as respondents were able to indicate more than one response.

Responses shown in Table 4 correspond roughly to the more common shark species found in Gulf coastal waters. The bull shark, perhaps the most abundant close to shore, is probably the least highly prized. Tiger and hammerhead sharks grow to larger sizes and are harvested less frequently. Respondents who mentioned a particular species usually indicated the species which they had not yet harvested or which they had caught least frequently. It is interesting to note that four anglers spontaneously indicated that their fishing aspiration was to catch a great white shark (or maneater). None realistically expected to ever catch a member of this relatively rare species (especially in the Gulf), but all expressed a great sense of fascination. Perhaps this preoccupation is a function of several recent popular works devoted to the great white.

How the study group perceives sharks was probed in two ways. First, an open-ended question asked, "In as few words as possible, how would you describe the way you feel about sharks?" Deliberately vague, the question was intended to ellicit initial reactions of perceptions of sharks. It was asked at the beginning of the interview. Responses have been grouped into categories based on similarity of ideas expressed and are presented in Table 5.

The first group of 36 responses (a majority of all responses) form a category which can be best described as feelings of respect and admiration for the creatures. Many related descriptive terms, from colloquial (neat) to technical (well adapted) to philosophical (compare to self), were offered. They all have in common a sense of praise and thus support our second hypothesis, that shark fishermen respect sharks as magnificent creatures and sport fish.

The second group of 15 responses imply feelings associated with the shark

Table 5.—Responses from 29 shark fishermen to the following question: "In as few words as possible, how would you describe the way you feel about sharks?"

Response	Frequency	Response	Frequency	Response	Frequency
Category: Feelings of Respect and Admiration		*Category: Feelings Associated with Fishing Experience*		*Category: Feelings of No Fear*	
Respect	9	Challenge	5	Not dangerous	1
Compare to self	1	Game fish	3	No fear	1
Strength	2	Compare to self	1		
Powerful	1	Sport	1	Total	[1]2
Intelligence	1	Love to fish for	3		
Elusive	1	Equal competitor	2	*Category: Miscellaneous Feelings*	
Neat	1				
All right	1	Total	[1]15	There to catch	2
Beautiful	1			Scavenger	2
Great creature	1	*Category: Feelings of Fear and Danger*		Poor man's marlin	2
Fascinating	3			Misinterpreted	1
Unknown	1				
Pretty	1			Total	[1]7
Streamlined	1	Afraid of	5		
Here to stay	1	Vicious	1		
Well adapted	1	Dangerous	2		
Perfect	1	They will attack	1		
Love for	1				
Intriguing	3	Total	[1]9		
Interesting	1				
Misinterpreted	1				
Equal competitor	2				
Total	[1]36				

[1]Totals indicate the number of times each response was offered. Since respondents often gave more than one descriptive term, totals are not addable.

fishing experience. These respondents immediately thought of sharks as prey, even though fishing was not mentioned in putting the question. Responses here complement those in the first category (some overlap enough to be appropriate for both groups) in supporting our hypothesis.

The remaining responses express fear, lack of fear, and some miscellaneous ideas. Combined they represent approximately 25 percent of all responses, a surprisingly low percentage in view of the open-ended nature of the question.

Secondly, respondents were asked at the close of the interview to identify the characteristic which best describes the way they feel about sharks. Six forced-choice alternatives were provided. Results are presented in Table 6.

Table 6.—Responses to, "Which of the following best characterizes the way you feel about sharks?"

Response	Number	Percent
A challenge to catch	21	72.4
Menace to people, they should be eliminated		0.0
Lords of the sea, they should be respected	5	17.2
Good food to eat, a product of the sea		0.0
Dangerous opponents	3	10.3
Other, please specify	—	0.0
Total	29	

n = 29 shark fishermen.

The three alternatives which were selected in Table 6 correspond roughly to the three major categories formed in Table 5. However, the emphasis is reversed for the two tables. The majority of spontaneous responses in Table 5 imply respect for sharks, while the second category involves the challenge to catch. In Table 6, on the other hand, a strong majority selected "a challenge to catch" over "lords of the sea, they should be respected." Apparently, providing the "challenge to catch" alternative induced more people to respond accordingly than would have responded spontaneously. In addition, this question was asked after several fishing participation and motivation questions which may have influenced the respondents to think in terms of the fishing experience. At any rate, it is reasonable to conclude that a vast majority of the study group perceives sharks either with a sense of respect for the creature or in relation to the fishing experience. Few of them indicated fear and none indicated hatred for sharks.

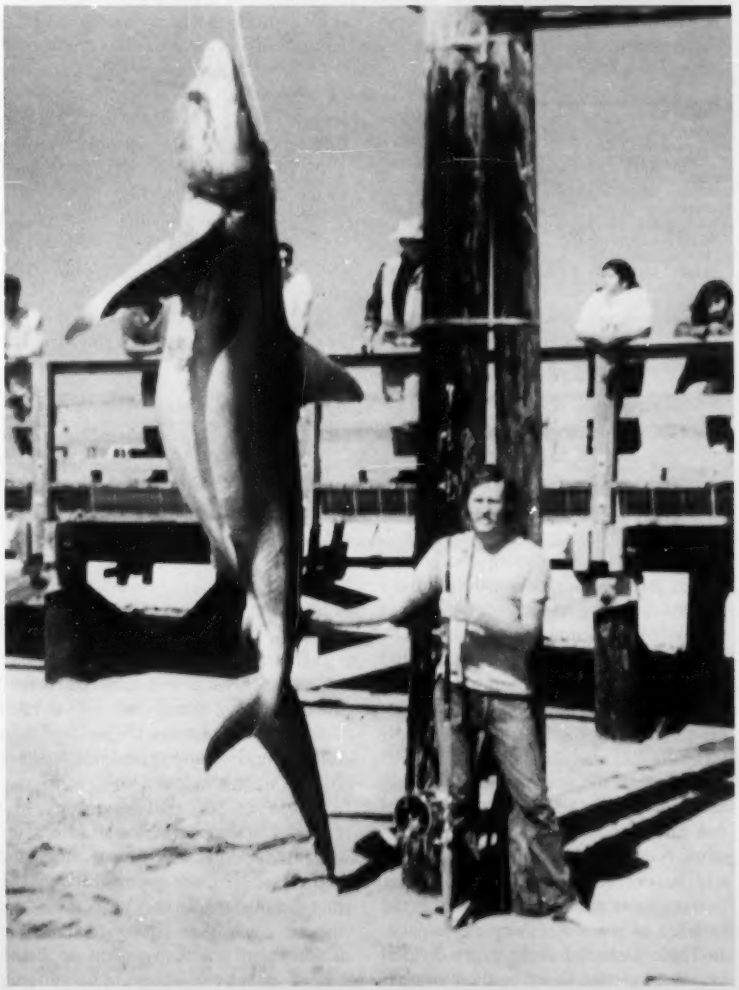
Several questions in the interview dealt with fishing motivation. One probed the most important reasons the respondents fished for shark and provided 10 response categories. Table 7 reports the percentages of fishermen which selected each aspect of fishing motivation.

The most popular response categories describe the fishing experience, not the catching of fish. Shark fishermen appear to enjoy most the challenge of fishing and being outdoors. Slightly less important are the aspects of being with friends, getting away from the regular routine, and relaxation. None of these factors are harvest related or dependent.

Table 7.—Responses[1] from 29 shark fishermen to the following question: "What are the most important reasons you fish for shark? Please check only those items that are most important to you."

Alternative	Percent
For the challenge or sport	96
To be outdoors	90
To be with my friends	83
To get away from the regular routine	79
For relaxation	62
To obtain a trophy	45
To obtain fish for eating	28
For physical exercise	24
For family recreation	21
Other	10

[1]Respondents were instructed to indicate those items most important to them. Multiple responses prevent percentages from being addable.



A 10' 9" dusky shark. Photo courtesy of the Corpus Christi Shark Association.

The selection rate drops below 50 percent for the response categories "to obtain a trophy" and "to obtain fish for eating." The relatively low importance of these two harvest related responses lends support to the notion that shark fishing is a complex behavioral phenomenon in which harvest accounts for only a small part of the total satisfaction derived.

In another effort to probe fishing motivation each respondent was provided with a list of factors and asked to indicate on a three point scale, the relative importance of each factor influencing his enjoyment of a typical shark fishing trip. While this artificial rating device does not provide precise measurement, it is useful in establishing overall ranking of factors on an ordinal scale. Table 8 reports the rank order of mean importance values for the factors.

Table 8.—Responses from 29 shark fishermen to the following request: "Please indicate the relative importance of each of the following factors which influence your enjoyment of a typical shark fishing trip."

Factor	Mean Importance Value[1]
Fight put up by fish	2.79
Pleasant companions	2.69
Ease of access to water	2.45
Water quality	2.41
Privacy while fishing	2.31
Weather conditions	2.28
Size of fish caught	2.24
Natural beauty of the area	2.10
Number of fish caught	1.86
Facilities available	1.69

[1]Scale = 1 (low) 2 3 (high)

Responses here are consistent with reasons for fishing reported in Table 7. Those aspects of fishing motivation which are most important derive from the entire fishing experience—fight put up by fish, pleasant companions, easy access, water quality, privacy, and weather conditions. The consumptive factors, size and number of fish caught, both receive low values of importance.

To further analyze the importance of fish harvest, the responses for "to obtain a trophy" (Table 7), "number of fish caught" (Table 8), and "size of fish caught" (Table 8) were cross tabulated with several other fishing variables. The first variable cross tabulated was the number of years of fishing experience. In Table 9, shark fishermen are divided into three groups based on their number of years fishing experience to probe the notion that, as the fishermen get older, they become less preoccupied with the fish they catch. The results do not bear this out. They imply that the least experienced and the most experienced fishermen are more concerned with the number and size of fish caught than the middle group. Surprisingly, the most experienced fishermen show the highest propensity for obtaining a trophy fish. It is also interesting to note that "size" is consistently rated more important than "number" of fish caught. Since the size of shark is directly related to the challenge or fight involved in the catch, this difference probably reflects the high value placed on the "challenge" aspect of the fishing experience.

Table 9.—Years of fishing experience by the consumptive aspects of the fishing experience.

Years experience	Percent fishing to get trophy	Importance of no. of fish caught	Importance of size of fish caught
0-5 (n = 15)	40	2.07	2.47
6-10 (n = 9)	44	1.44	1.88
>10 (n = 5)	60	2.0	2.2

When shark fishermen are grouped according to the number of sharks they harvested and cross tabulated with some of the consumptive aspects of fishing (Table 10), several trends are evident. First, those who didn't catch any sharks were not very concerned about catching them. Only one-third of them fished to obtain a trophy, and their ratings for the number and size of shark caught were relatively low.

Table 10.—Number of sharks caught last year by the consumptive aspects of the fishing experience.

No. caught	Percent fishing to get trophy	Importance of no. of fish caught	Importance of size of fish caught
0 (n = 15)	33	1.71	2.07
1-7 (n = 11)	54	2.18	2.54
13,18, 19 (n = 3)	67	1.67	2.0

Those in the middle group, who caught from one to seven sharks, rated the number and size of fish caught the highest of all three groups. It may be that the few sharks they did catch gave them enough of a taste of the battle to make them anxiously want to catch more.

Those who caught the most sharks showed the lowest concern for the number and size of fish caught, but the greatest concern for obtaining a trophy. Perhaps for these few very successful shark fishermen, the real challenge lies in catching the trophy fish.

When these same consumptive factors are cross tabulated with the extent of fishing participation (Table 11), it is apparent that those who fished most often were the most interested in catching a trophy and the most concerned with the number and size of the fish caught. The differences between the casual (0-10 fishing experiences during the previous 12 months) and the avid (greater than 10 fishing experiences during the previous 12 months) fishermen are substantial. The data suggest that the avid group is much more highly motivated by catch-related aspects of shark fishing.

Table 11.—Extent of participation by the consumptive aspects of the fishing experience.

No. fishing experiences in previous 12 mo	Percent fishing to get trophy	Importance of no. of fish caught	Importance of size of fish caught
0-10 (n = 13)	23	1.58	1.92
>10 (n = 16)	62	2.06	2.5

Several general observations can be made to summarize the fishing motivations of the study group:

1) The challenge or sport of fishing is the most important aspect of fishing motivation for the shark fishermen.

2) Many other factors contribute to the enjoyment of the total shark fishing experience. These include being outdoors, being with friends, getting away from the regular routine, relaxation, water quality, privacy, and weather conditions.

3) The consumptive aspects of fishing are of relatively low importance to respondents. Shark fishermen are generally more concerned with the size of shark caught than with the number caught. Those who fished often are considerably more interested in the size and number of fish caught and with catching a trophy than are those who fished only occasionally. Those who caught no sharks or many sharks are less concerned with the size and number of fish caught than those who caught a few sharks, but those who caught the most are also the most interested in catching a trophy shark. While these intra-group

comparisons are interesting, it is important to remember that the consumptive factors, "size of fish caught," "number of fish caught," and "to obtain a trophy," are all rated lower in importance by the entire group than all of the other aspects of fishing motivation discussed in 1) and 2) above. It is apparent that shark fishing involves far more for its participants than catching sharks.

COMPARISON OF SHARK FISHERMEN AND OTHER FISHERMEN

Two other fishing motivation studies will be considered here, for they provide the basis for comparisons between shark fishermen and other groups of fishermen. A study of Wyoming trout anglers was selected to represent another specialized group of fishermen, and a study of New York lake and stream fishermen was selected to account for less specialized anglers.

Ballas et al. (1974) surveyed trout fishermen in Gallatin Canyon, Wyo. As in this study of shark fishermen, trout anglers were asked, "What are the most important reasons you fish?" The same alternative responses were provided in both studies.

There are several similarities in findings. First, "to be outdoors," "for the challenge or sport," and "to get away from the regular routine" are rated highly by fishermen in both studies. Likewise, "to obtain a trophy," "to obtain fish for eating," and "for physical exercise" all receive low rankings in both studies. It appears that in both studies consumptive aspects of fishing are not predominant among fishermen.

Some differences between the shark fishermen and the trout fishermen are also noteworthy. Shark fishermen indicated "to obtain a trophy" considerably more than "to catch fish for eating," while the reverse was true for the trout fishermen. This is due likely to a functional difference between trout and shark fishing. Trout are caught more frequently and are generally prized as good-eating fish. In comparison, catching a large shark is a rare event, and only small ones of certain species are kept for eating. Another complicating factor is that shark fishermen almost always fish for other types of fish while they are shark fishing. Those who checked, "to obtain fish for eating," as an important factor may well have been referring to the fish they catch on their lighter rigs, rather than the sharks they catch.

A 9' 5" lemon shark. Photo courtesy of the Corpus Christi Shark Association.

The higher ranking of, "to obtain a trophy," by the shark fishermen is consistent with their higher ranking of, "for the challenge or sport." These two alternatives are related in that they both imply a sense of achievement. The discrepancy between the two study groups might suggest that shark fishermen are more highly motivated by achievement while trout fishermen are most strongly motivated by temporary escape and experiencing natural settings.

A significant difference between the two groups is their reaction to the factor, "to be with my friends." Shark fishermen rated this highly while trout fishermen generally did not. This again is probably due to differences between the two angling activities. While trout fishing is often an individual, solitary activity, shark fishing almost invariably involves a small group, and often doubles as a camping trip or social outing among friends.

Moeller and Engelken (1972) probed "what fishermen look for in a fishing experience" with a survey of one hundred New York lake and stream fishermen. Their study utilized the

A 9' 2" sand tiger shark. Photo courtesy of the Corpus Christi Shark Association.

artificial factor-ranking device discussed earlier (Table 8).

Two factors were added to the question put to shark fishermen because of their direct applicability to shark fishing. These two factors, "fight put up by the fish" and "pleasant companions," received the highest overall rankings for shark fishermen. This is consistent with the responses to why they fish: "for the challenge or sport" and "to be with my friends."

For both groups, "privacy while fishing" and "water quality" received high rankings. Conversely, the "number" and "size" of fish caught were relatively low in importance in both studies. "Ease of access to water" and "facilities available" are not really appropriate factors for Gulf shark fishing because access is not a problem and facilities are unnecessary.

One notable difference is that "natural beauty of the area" was ranked highly by the New York fishermen group and was relatively low in importance for shark fishermen. Here again, a direct comparison is not appropriate, for it is possible that the difference reflects different perceptions by the two groups of what "natural beauty" is, rather than a true motivational difference between the two groups. The coastal environment of Texas is very different from the lake and stream environment of New York State. As a result, it is likely that environmental values and perceptions also vary for recreationists in the two areas. For example, many shark fishermen respondents indicated that they did not feel the Gulf coast is an area of "natural beauty" and gave this factor a low ranking. On the other hand, it would be useful to probe how New York fishermen perceive "natural beauty." Based on their strong attraction to this as a motivational factor, it can be hypothesized that New York anglers do indeed regard their lake and stream fishing environment as "naturally beautiful."

In general, the observation that can be made from this analysis is that, once again, non-consumptive aspects of the fishing experience are the most important factors affecting the enjoyment of fishing for both groups.

CONCLUSIONS AND IMPLICATIONS

Two general conclusions are possible in this paper, and they are in support of the hypotheses stated earlier. First, shark fishermen do not indicate a hatred for sharks. They do not indicate a fear of them. Shark fishermen tend, for the most part, to perceive sharks either as magnificent animals to be respected or in relation to the fishing experience they provide.

An interesting sidelight here is that shark fishermen in this study group are quite knowledgeable about sharks. Besides knowing how to fish for them, many understand a great deal about shark taxonomy, physiology, and behavior. Perhaps the adage, "familiarity breeds respect, unfamiliarity breeds contempt," is directly applicable. Results of this study certainly demonstrate that shark fishermen have a different relationship with sharks than is popularly portrayed in the literature for the rest of mankind. While the public is

often preoccupied with the sensationalism of sharks, shark fishermen appear to understand the shark species and enjoy a comfortable relationship with sharks based on respect and admiration.

Secondly, like other groups of fishermen studied previously, shark fishermen fish primarily for nonconsumptive reasons. Their top interest is the challenge or sport of fishing; yet the size and number of fish caught are of relatively little importance to them. What is more important to these fishermen is that they be outdoors, with their friends, and away from their regular routine.

Comparison of fishing motivations of shark fishermen and other fishermen groups previously studied demonstrates that shark fishermen are not a group of specialty predator or meat fishermen, but rather have attitudes and motivations similar to those of other fishermen.

FURTHER RESEARCH

Following this exploratory effort, the next logical research step should be to study a representative sample of shark fishermen. A basic question to fishery managers is just how important is shark fishing? Determination of this can suggest to fishery managers what type of effort should be devoted to a possibly sizeable and growing constituency. Indications of preferences and motivations of shark fishermen in this study group might be useful in helping to design further attitudinal inquiries. It would be interesting to see if the same factors that contribute to a quality fishing experience for this study group will also be important to a representative sample of shark anglers elsewhere. What is learned can be used by fishery managers to identify specific expectations and determine management alternatives aimed at providing satisfactory fishing experiences.

It would also be interesting to compare characteristics and attitudes of shark fishermen to those of other big game anglers, such as billfishermen. Because of the different nature of the two activities, a study of marlin and sailfish anglers might reveal that they do comprise a group of specialty predator fishermen with attitudes and motivations very different from shark fishermen and fishermen in general.

A 12' 2¼" tiger shark. Photo courtesy of the Corpus Christi Shark Association.

Perhaps the most important implication of this study is that it is a beginning step towards a better understanding of the sport of shark fishing and its participants. Currently, there are many other surveys of fishermen's attitudes, preferences, and motivations underway in different areas of the country. The findings of these user surveys will collectively provide more insight into what fishermen do seek in their fishing experiences.

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MFR PAPER 1176

An Automated Unmanned Fishing System to Harvest Coastal Pelagic Fish

WILBER R. SEIDEL and THOMAS M. VANSELOUS

ABSTRACT—Coastal pelagic fish resources of the Gulf of Mexico are basically unutilized with the exception of menhaden, which are harvested extensively. The other fishes of the coastal pelagic group represent a resource which has been estimated to be nine times larger than the menhaden resource, but cannot be profitably harvested by traditional purse seining techniques. The various species do not naturally form large schools as do the menhaden, and are often found in shallow water over rough bottom areas which limit the use of purse seines. Described is an automated fishing system that offers a method to effectively harvest the coastal pelagic fish resource. This system would be unmanned from harvesting through processing; the only manpower or vessel requirement would be to service and maintain fishing platforms and to offload the processed products.

INTRODUCTION

Harvesting coastal pelagic fish in the Gulf of Mexico consists primarily of purse seining for menhaden (*Brevoortia* sp.) for reduction to industrial products, mainly fish meal and oil. There are indications that the catch of menhaden in the Gulf has reached or perhaps surpassed the level of sustainable yield. At best, this species is only the third, and perhaps only fifth, most abundant coastal clupeid in the Gulf of Mexico (Bullis and Carpenter, 1968).

Other latent pelagic resources of the Gulf offer excellent opportunities to the fishing industry. They include herrings, anchovies, and jacks, which are available from the coast to the edge of the Continental Shelf. Personnel of the National Marine Fisheries Service (NMFS) at Pascagoula, Miss., have estimated the standing stock of coastal pelagic fishery resources to be over 11 million tons (Klima, 1970). For example, stocks of Atlantic thread herring (*Opisthonema oglinum*) have been estimated at about 1 million tons (Bullis and Thompson, 1967).

Attempts to harvest latent coastal pelagic fish have been generally unsuccessful because the fish avoid mid-water and bottom trawls (Klima, 1970). Their behavior makes capture with standard purse seines ineffective. Unlike menhaden, these pelagic fish are usually found in numerous small schools (2-5 tons), making it economically unfeasible to use purse seines for capture. When large schools are found, they often divide into smaller groups that are extremely fast and difficult to encircle with a purse seine (Butler, 1961). In addition, purse seines have not been suitable for harvesting coastal pelagic fish in some areas because rough bottoms and shallow water inhibit extensive seine-type operations.

Economic factors are compounded because coastal pelagic fish are not highly concentrated and range over vast areas. When used for reduction into fish meal or fish protein concentrate (FPC), the fish must be harvested inexpensively by capturing large quantities in a relatively short time, close to a processing plant. Various techniques have been tested to locate schools; the most successful has been the use of aircraft with spotter pilots. Present harvesting techniques and gear are inefficient, but dockside processing of the catch has evolved to almost total automation. As a result, the cost of acquiring the raw material is the dominant factor controlling the price of the end product. The Southeast Fisheries Center of NMFS and its predecessor agencies have proposed the development of automated fishing systems as a potential solution to the problem of economically harvesting coastal pelagic fish.

SYSTEM DESCRIPTION

There are an estimated 1,000 unused oil rig platforms and structures in the Gulf of Mexico and several thousand more which are oil producing units. Recreational fishermen have demonstrated the usefulness of these platforms

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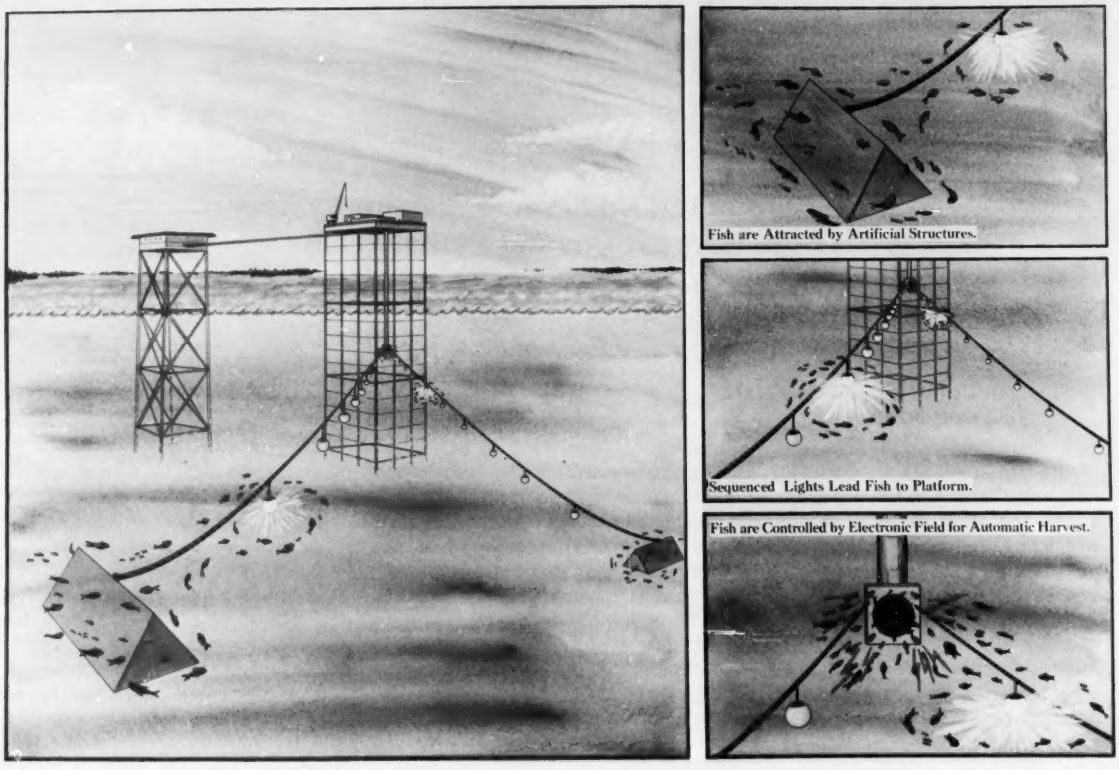
Fish are Attracted by Artificial Structures.
Sequenced Lights Lead Fish to Platform.
Fish are Controlled by Electronic Field for Automatic Harvest.

Figure 1.—Artist's concept of an automated fishing station on an offshore oil platform.

as attractors of food fish such as red snapper, lemonfish, grouper, and drum, and it is known that coastal pelagic fish are also attracted in great numbers. These platforms are an integral component of the proposed automated unmanned fish harvesting system, although in areas without such platforms groups of man-made underwater structures could be used.

The proposed system would be based on the unused oil rig platforms as attractors of coastal pelagic fish. The fish that congregate around and under the platforms would be periodically harvested with the aid of attraction lights and electrical fields. An automatic processing vessel or barge, with attraction and harvesting equipment installed on it, would pump the fish from the electrical field into onboard automatic processing machinery where the fish would be converted into fish meal and oil. An alternative to this approach would be to install electrical hardware and automatic processing machinery on the platform itself (Fig. 1). Fish would be periodically pumped into automatic processors and the resulting fish meal or FPC stored on the platform to await collection by a shuttle boat.

Additional small attraction devices could be deployed outward from and around the oil platforms to increase fish concentrating capability. Through the use of sequential lighting or main attraction lighting, either under the platforms or aboard the processing barge, the fish could be concentrated and harvested from the electrical field.

There are advantages and disadvantages to the barge and platform processing techniques. An automatic processing barge would offer more flexibility and mobility to the overall harvesting operation and the initial cost perhaps would be less. However, permanently fixed processing and harvesting equipment on each platform would offer the capability for continuous fishing at multiple locations which might offset any increased initial capitalization.

SYSTEM COMPONENTS

Attraction Devices

In many parts of the world, commercial fishermen have harvested pelagic fish that congregate around floating objects (rafts, logs) and near fixed structures (Hunter and Mitchell, 1967). Evaluations of artificial floating objects reported by Hunter and Mitchell (1968) revealed that pelagic fish are attracted more to submerged three-dimensional structures, resembling small tents, than to horizontal or vertical plane surfaces.

Klima and Wickham (1971) and Wickham and Russell (1974) experimented with structures patterned after Hunter and Mitchell's (1968) successful design. Their studies indicated that artificial structures were effective for concentrating coastal pelagic fish in the Gulf of Mexico. During a 20-day observation period, 25 metric tons of fish were attracted to a structure on one occasion, and in six other instances at least 5 metric tons of fish were attracted. The

studies revealed a very rapid rate of initial attraction, indicating that the fish could be harvested at frequent intervals.

Field studies to determine the attraction of coastal pelagic fish to night-lights were reported by Wickham (1971a, 1973) and Wickham and Seidel (1973). A single light used in conjunction with a conventional purse seine yielded approximately 4,000 pounds of fish in 3 hours. Multiple lights, properly spaced, appeared to act as independent attraction points and it was demonstrated that fish attracted to one could be led by sequentially illuminating the series of lights. A single moving light also proved successful in leading fish. Use of artificial structures in conjunction with light attraction significantly increased the density of fish concentration.

Control Techniques

Laboratory experiments were conducted by Klima (1972) to identify the electrical characteristics needed to induce electrotaxis as a means of controlling and leading fish. He used a modified electric shrimp pulse generator which produced pulsed direct current in the form of capacitor discharges at a rate of 5-75/second. An index of optimal responses was obtained for selected species (Table 1).

Table 1.—Effective combinations of voltage (per 10 cm) and pulse rate (per second) for inducing electrotaxis in the species studied and the approximate amperes (per square meter) (Klima, 1972).

Species	Volts	Pulses	Amps	Fish length (mm) Range	Fish length (mm) Average
Coastal pelagic fish					
Scaled sardine	1.5	15-55	62.5	100-145	118
	3.0	8-28	86.5	100-145	118
Spanish sardine	1.5	35-45	43.3	85-180	130
	3.0	15	86.5	85-180	130
Round herring	3.0	25-45	86.5	80-150	104
Silver anchovy	3.0	35-45	98.3	85-110	96
Butterfish	1.5	35	41.3	80-100	118
	3.0	45	86.5	80-160	118
Chub mackerel	1.5	15	53.8	125-240	180
Bumper	1.5	15	57.0	135-230	173
Rough scad	1.5	15-25	42.3	120-145	133
Thread herring	1.5	15	62.5	80-185	146
Round scad	1.5	15	43.3	90-170	148
Bottom fish					
Spot	1.5	15-35	43.3	90-250	120
Longspine porgy	1.5	25-35	43.3	100-160	128

Klima (1972) reported that guiding or leading coastal pelagic fish to the anode was easily accomplished within a uniform electric field. Nonuniform fields—a gradation of voltage which increases as the fish approach the anode—caused the fish at the outer edges to undergo a fright reaction because of the low-voltage gradient. Fish in the center of the field underwent electrotaxis and swam toward the anode until the voltage increased sufficiently to cause tetanus. Fright and tetanus responses are undesirable for leading fish; however, fish can be led considerable distances without these responses in a uniform field. Thus an electrode array should be designed to produce an electric field as close to uniform as is possible in the area where electrotaxis is wanted.

The behavior of fish in an electrical field is dependent on the voltage applied, pulse rate, and length of the animal, since the voltage potential increases proportionately with length. To substantiate the accuracy of electrical characteristics established in the laboratory, an intermediate-size pulse generator and test electrode array were constructed to conduct in situ tests (Seidel and Klima, 1974). Fish were attracted into the electrode array and their responses to various combinations of electrical fields and pulse rates were evaluated to determine the requirements of an electrical system which could succeed in the full-scale commercial harvesting of coastal pelagic fish.

The tests conducted by Seidel and Klima (1974) enabled them to compute the size of an electrode array to harvest commercial quantities of coastal pelagic fish, and the electrical field and pulse generator characteristics necessary to produce the proper stimulation to lead and control the fish. Pulse generator and electrical system criteria established by these tests were used subsequently to design and purchase a pulse generator with an output capability of 120 kw into a load resistance of 0.02 ohm at variable pulse rates and pulse widths. The system, now installed on the RV *Oregon II* (Fig. 2), provides the capability to lead and control pelagic fish in commercial quantities so that rapid, efficient capture and harvest can be accomplished.

Pumping and Processing Equipment

Most of the pumping and processing equipment required to complete the automated fishing system is available commercially. Adaptation of an electrode array and possibly a small secondary pulse generator around the pump intake, however, might be required. The most feasible system output appears to be pelletized fish meal similar to that produced in several South African countries. This processing method alleviates the requirement for aerating the fish meal as part of the drying process and also prevents combustion. It would also expedite transfer and handling of the product between the platform and service vessel and at the shore facility.

Concept of Operation

The two methods available for using the automated concept to commercially harvest coastal pelagic fish already have been briefly discussed. The first method uses an automated fish processing barge to service fish concentrations and harvesting sites. The harvesting and processing vessel would service several sites in an area nightly or at whatever time interval is determined to be optimum. Installed on the vessel would be a pulse generator, electrode array, fish pump, fish processing equipment, and other hardware, including storage facilities, necessary to accomplish automated harvesting and processing of the fish. A minicomputer would be necessary at each site to properly activate the concentrating and holding lights. The lights would be automatically turned on about sundown and, if a series of satellite structures were used, the computer would also activate sequential lights to lead fish from the satellite structures to the main platform. The

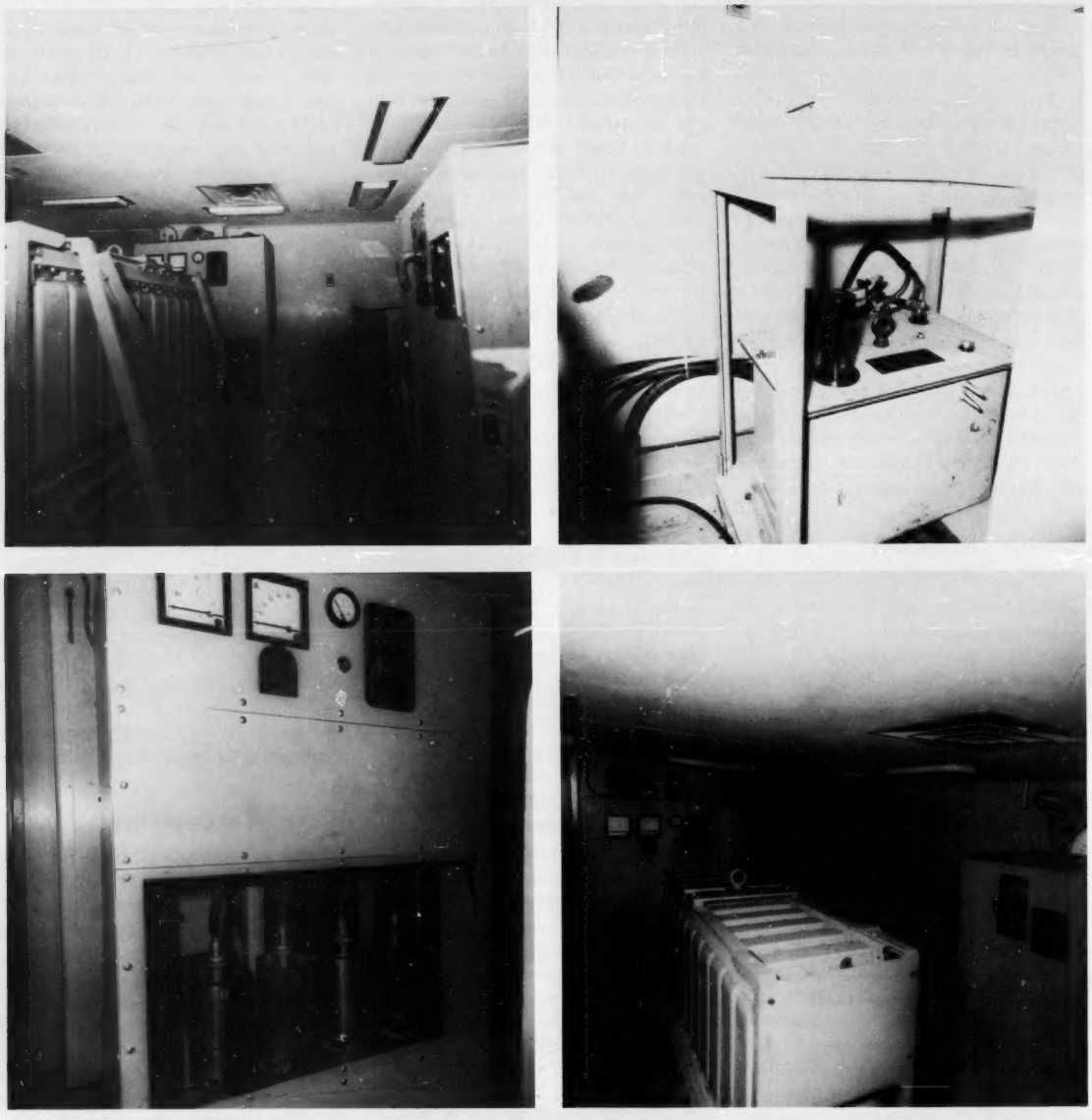

Figure 2.—120 kw pulse generator on FV *Oregon II*. Components shown (left to right, top to bottom) include: input/compensating pulse capacitors and rectifier unit, output transformer, main control unit, and a composite picture including the variable input transformer in background.

fish would be held by the main light for harvest by the processing vessel.

The second method identified for harvesting coastal pelagic fish is to make each major offshore oil platform an independent automated fishing system. To do this, each platform would be equipped with a pulse generator, electrode array, attraction light, fish pump, and automated processing equipment. Again, a minicomputer would be necessary to activate the sequential leading lights from the satellite structures to the main holding light and to properly sequence the electrical field, fish pump, and processing equipment. A small sonar system could be used to evaluate fish biomass at the pump inlet to enable the computer to determine the feasibility of activating the pumping and processing operation.

The automated fish harvesting platform offers an advantage in that the complete sequence of fish harvesting and processing events could be repeated several times a night at each platform, whereas with the automated pro-

cessing barge, the vessel probably could harvest fish from each platform location only once each night. Additional studies are needed to determine the length of time a group of fish can be held after sundown before they lose interest and leave a light field. If fish can only be held from 2 to 3 hours after sundown, a service vessel may be able to visit only one to two locations each night and would need to harvest a larger volume of fish at each stop. To decide which method is most economical, the potential production of an area and the probable rate of production will have to be determined and compared against system costs. The possibility of combining any of the subsystems or procedures suggested in the two systems described above also should be considered.

PRESENT CONSTRAINTS

Using abandoned oil rigs as platforms for automated fishing systems will cause concern among the recreational fishermen of the Gulf Coast. Oil rigs are a known habitat for many species of fish that are sought by sportfishermen, and sportsmen may experience a feeling of encroachment by the commercial fishing industry. Because of their distance offshore, however, many rigs are inaccessible to the average sportsman. Careful selection of potential sites and proper management controls should obviate the sportsmen's concern. In addition, selectivity characteristics of the electrical field on different species of fish and the predator/prey zonation of fish around lights at night can also be used advantageously to harvest only the smaller, coastal pelagic commercial species.

Selection of productive sites will be difficult, requiring definitive predictive capabilities. Surveys conducted by NMFS research vessels will supply inputs as will industry catch/effort records.

Even though submerged objects and lights are effective fish attraction devices, one question still arises, "How frequently can a harvestable quantity be attracted?" Results of tests conducted by Klima and Wickham (1971) and Wickham and Russell (1974) suggest that the pelagic fish populations congregating around attraction devices are transient schools that constantly move into and away from the structures. This implies that the leading away of one congregation will not impact subsequent operations. With regard to the effects of environmental and biological variables, Wickham (1971b) reported that experimental fishing trials were required to define their effects on production levels.

Fish near attraction devices generally can be led by sequential or moving lights without regard to species or size. However, Klima (1972) reported that the response of a fish in an electrical field depends upon voltage and the length of the animal, because the voltage potential increases proportionately with length. Evidence from the same study indicates a combination of electrical factors that induce electrotaxis in one species may induce fright or no response in another. Further study of fish behavior in electric fields may identify optimum voltages or voltage gradients that would induce the desired effect on target species while repelling unwanted species. For example, it has been shown that in a light field predators tend to remain in the darker fringes and therefore probably would only be exposed to the fringe area of the electric field, which is not effective in leading or controlling fish.

If many discrete harvesting platforms are used, the possibility exists that the pumping and processing systems will be activated when an insufficient quantity of fish is concentrated at the nozzle intake. Sonar systems have been successfully used to locate living marine resources and tests are being conducted to establish techniques to quantify biomass. A sonar-type device, scanning the area immediately surrounding the pump nozzle, could provide biomass measurements to be used by a small computer for operating decisions.

Fish meal currently is produced in a powdery form that requires several aeration cycles for drying. Present techniques are not readily adaptable to the suggested automated processes or to wind exposure. Shipboard processing ventures have adapted techniques used at shore-based plants, but manpower is required. Attempts to apply vat storage aeration techniques generally have been unsuccessful. As an alternative, fish meal could be pelletized or processed into a press cake form after the addition of butylated hydroxytoluene or bacteria retardants to facilitate storage.

System maintenance would require different expertise than is presently existent in the industrial fishery, but neither the reliability of the equipment nor the periodicity of maintenance should represent serious problems. Most of the components should be commercially available by the time a system is operational. Developmental research and pilot plants will have demonstrated system integrity and resolved the inherent problems associated with design and construction of the various components. The establishment of effective operational control procedures, development and testing of the software required to operate the system, and troubleshooting and identifying problems will represent the more critical factors in system development.

The exact cost of an automated fishing system is unknown. It is reasonable to assume, however, that the cost would be less than the investment required to purchase and equip a purse seining fleet to catch a comparable harvest. At this time, the apparent savings is in manpower—instead of the normal 8-9 man crew on each of many purse seine vessels, only one seagoing crew would be required on each of a few automated service barges or shuttle boats. Dockside manpower would also be reduced since the catch would already be processed. Another cost factor to be considered is the possible addition of a transfer system to enable shrimpers to periodically offload their discards for processing into fish meal and oil. This would be advantageous to both parties and its feasibility for offering a solution to the sizeable shrimp discard problem should be investigated.

BENEFITS

The automated fishing system is a potential method for realizing the economical utilization of the estimated 11 million tons of latent coastal pelagic fishery resources in the Gulf of Mexico. Many of these resources are unexploited because they cannot be harvested with existing gear. The proposed automated fishing system should obviate many of the problems which have prevented significant harvest of this latent resource, and result in a substantial increase in the industrial fishery harvest while at the same time reducing harvesting and processing costs. The length of

the fishing season, presently limited to about 6 months for menhaden, could be extended due to the availability of coastal pelagic fish in various areas of the Gulf of Mexico throughout the year.

Obviously the system must be designed, developed, and tested before the actual cost savings can be quantified; however, several cost reduction factors seem apparent. The expansion of the potentially harvestable resource base will increase harvest production and should remove some of the seasonal restrictions. Automated systems will significantly reduce manpower requirements. Fleets of purse seine vessels will not be necessary; therefore, seagoing crews will not have to be employed. At a time when fuel supplies are becoming critical, reduction of the fishing fleet will definitely reduce fuel requirements and costs. Landings of processed fish meal and oil will reduce the size of the shore-based labor force and offer an alternative solution to meeting pollution standards associated with shore-based facilities.

Implementation of the automated fishing concept could potentially increase raw fish stock production of fish meal and oil by as much as 25 percent. At this rate, based on the 1974 Gulf of Mexico menhaden fish meal production of approximately 593,000 metric tons, the automated fishing system could represent an increase in meal production of 148,000 metric tons and 30-35 million dollars annually, not including oil.

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U.S. Fisheries Gain at ICNAF Meeting

All major United States proposals before the International Commission for the Northwest Atlantic Fisheries (ICNAF) were accepted during the special Commission meeting that ended 28 September 1975 in Montreal, Canada. David H. Wallace, Chairman of the U.S. delegation and Associate Administrator in the Department of Commerce's National Oceanic and Atmospheric Administration, characterized the special meeting as "one of the most successful in the Commission's 25-year history from the standpoint of the United States."

The Commission acted to: 1) reduce substantially the 1976 overall catch quota for all finfish species off the northeast coast of the United States, while at the same time providing an increased quota for the U.S. which will allow expansion by our fishermen; 2) close most of the Georges Bank area to large vessels capable of catching valuable and depleted groundfish stocks; 3) approve a system for registering fishing vessels of every nation in the area; and 4) establish more enforceable exemption provisions for trawl net fisheries conducted off the U.S. and Canadian coasts. Also, the U.S. quota was increased to 230,000 tons from 211,600 tons in 1975.

The seventh special meeting of the 17-member-nation body was called at the request of Canada and the United States to obtain reduction of fishing effort and quotas in the convention area. The Commission had failed to require these reductions at the annual meeting of ICNAF in June even though the United States and Canada had pressed for immediate action. The United States consequently had filed formal objection to the quotas then set, in conformity with the rules of the Commission.

A principal U.S. objective at the September meeting was to obtain an overall fishing quota for the area off the U.S. coast that would make possible rapid recovery of the overfished and depleted species. This was accomplished through a "second tier quota" system. In addition to establishing quotas for each species of fish and for each nation—the "first tier quotas"—the agreement establishes a tonnage quota for each nation that is less than the total of quotas for individual species—the "second tier quotas." The "second tier" system penalizes fishing vessels for the incidental groundfish catches they make, impelling them to concentrate on the species of most interest to them.

The total quota for 1976 was established by the special meeting as 650,000 metric tons, including squid. At the June meeting the Commission had established a total quota of 724,000 metric tons, excluding squid, which was the basis of the U.S. formal objection. The new level, say U.S. fisheries scientists, provides a high probability of recovery of depleted species within a reasonable period of time.

The Montreal meeting also agreed to close a large area on Georges Bank to larger vessels that use gear capable of catching seriously depleted groundfish such as flounder and haddock. Smaller vessels, or larger vessels that do not have groundfish gear, can continue to fish the area. This agreement effectively rules out foreign fishing in the area by vessels with groundfish gear.

The new vessel registration provisions require that fishing vessels planning to fish in the regulated area must give advance notice of their intentions and when and where they are going to fish. This system will assist member governments and international enforcement personnel to achieve more effective monitoring of fishing in the area.

Canada was successful in obtaining approval for a regulation designed to reduce substantially fishing effort on groundfish stocks in five portions of the convention area off the Canadian coast. The Cuban observer announced that action required for Cuba to become an ICNAF member would be immediately initiated by his government.

"Second tier" quotas established at the special meeting are as follows:

Country	1975 quota	1976 quota
Bulgaria	24,550	14,400
Canada	26,000	18,000
France	2,950	2,950
West Germany	24,850	14,900
East Germany	82,850	48,750
Italy	4,150	6,800
Japan	21,250	18,000
Poland	129,250	76,500
Rumania	3,850	3,850
Spain	14,800	16,000
Soviet Union	301,800	177,250
United States	211,600	230,000
Others	2,000	1,600
Cuba	—	21,000
Totals	850,000	650,000

Marine Game Fish Tournament Data Published

Detailed information on the catch results of 33 big-game fishing tournaments held in 1974, highlight the third annual edition of the Oceanic Game Fish Investigations Newsletter, produced under the auspices of the National Oceanic and Atmospheric Administration.

Scientists from NOAA's Southeast Fisheries Center at Miami, Fla., compiled and analyzed the extensive data appearing in the newsletter. They also served as scientific observers at many of the fishing tournaments. Additional data were obtained in cooperative sampling arrangements with the Florida Department of Natural Resources, the South Carolina Wildlife and Marine Resources Department, and the Georgia Department of Natural Resources.

The publication by the Commerce Department agency results from a cooperative program between oceanic game fishermen and National Marine Fisheries Service scientists. In general, it presents synopses of billfish catches (blue marlin, white marlin, and sailfish) in the northwest Atlantic, the Gulf of Mexico, and the Caribbean Sea. Fishing effort is compared to catches, the most productive time of day for billfish catches is noted, and historical data about weights and distribution patterns for the fish are presented.

In 1974, game fish tournaments north of Cape Hatteras, N.C., were sampled for the first time. A 50 percent increase in the number of white marlin hooked over 1973 reflects this additional coverage of the great white marlin fishing grounds off the mid-Atlantic coast. Data in the newsletter are supplemented by listings of billfish catches in the western Atlantic Ocean from 1957 to 1972, obtained from the Japanese longline fishing fleet.

Results of the first full year of joint research on the tuna and billfish stocks in the Atlantic Ocean under the National Marine Fisheries Service-Woods Hole Oceanographic Institution Cooperative Game Fish Tagging Program are included. Over 1,800 game fish were tagged; 673 of these were sailfish released off the southeast coast of Florida and off Cozumel, Mexico. Seventy-nine recoveries of tagged game fish were recorded in 1974. Amberjacks provided the most returns (25) with small bluefin tuna second (19). One giant bluefin tuna tagged off the Bahamas was recaptured off Norway 461 days later. An amberjack was recaptured by the same captain who tagged and released it exactly 365 days earlier at the same location in the Florida Keys.

Copies of the 1974 Ocean Game Fish Newsletter may be obtained from the Southeast Fisheries Center, National Marine Fisheries Service, NOAA, 75 Virginia Beach Drive, Miami, FL 33149.

King Crab, Salmon, and Lobster Fisheries Called "Conditional"

The Commerce Department has declared the American lobster in the Gulf of Maine; the salmon fishery in Washington, Oregon, and California; and the Alaskan King Crab fishery to be "Conditional Fisheries."

Commerce Department regulations consider a Conditional Fishery as one where there are already sufficient vessels to harvest the available catch. The National Oceanic and Atmospheric Administration's National Marine Fisheries Service has determined that these fisheries have more than enough vessels involved in the harvest.

Being declared a Conditional Fishery means that the NMFS financial assistance programs cannot be used to add more vessels to the fishery's existing fleet, but can be used to assist the vessel owners in the fishery to upgrade existing vessels, or to replace vessels lost or withdrawn from the fleet.

NMFS financial assistance programs offer benefits to help commercial fishermen modernize their vessels. Under the Fishing Vessel Guarantee program, NMFS can now provide lenders an attractive service, fully guaranteeing obligations incurred by fishermen to finance up to 75 percent of the cost of constructing, reconstructing, or reconditioning commercial fishing vessels.

The capital Construction Fund program may be used to obtain deferment of taxes on certain income derived from commercial fishing operations when such income is deposited in a special fund with the intention of using it for constructing, acquiring, or reconditioning a commercial fishing vessel. Notice of these declarations appeared in the Federal Register the week of 22 September 1975.

Director Named for NOAA OCS Environment Program

Rudolf J. Engelmann has been appointed director of the National Oceanic and Atmospheric Administration's Outer Continental Shelf Environmental Assessment Program in Boulder, Colo. The multimillion-dollar study seeks to determine the probable ecological impacts of oil exploration and development activities on Alaska's Outer Continental Shelf.

During the early years of the program, investigators will examine intensively the life forms and physical environment of the Outer Continental Shelf of Alaska, focussing on eight oil leasing areas spread among the Gulf of Alaska, Bering Sea, Chukchi and Beaufort Seas. They will evaluate the roles that natural processes play in spreading contaminants from petroleum development sites, how marine life would be affected, and what natural hazards face oil development activities in this region. The study is being conducted by the Commerce Department agency's Environmental Research Laboratories for the Interior Department's Bureau of Land Management.

Before joining NOAA, Engelmann was Deputy Manager for the environmental research of the U.S. Energy Research and Development Administration and its predecessor organization, the Atomic Energy Commission. Prior to that he led the agency's Fallout Studies Branch, concerned with planning and managing basic research programs in support of the nation's need for better knowledge of radioactive fallout processes.

Engelmann formerly was employed by Battelle Northwest in Richland, Wash., where he designed and conducted research projects and experiments in meteorology. In the Air Force during the 1950's, he was a weather observer and forecaster in various states and Labrador. Engelmann received a B.A. degree in mathematics from Augsburg College at Minneapolis, Minn., in 1950. He subsequently attended New York University and the University of Washington at Seattle, from which he received a Ph.D. degree in atmospheric physics in 1964. The Kenmare, N.D., native and his wife, Virginia, live with three children in Boulder, Colo. Three other children are in Pennsylvania and Maryland colleges.

Foreign Fishery Developments

Portugal, Canada Discuss Marine Fisheries

Portuguese and Canadian delegations met in Ottawa on 4 and 5 September 1975 to discuss fishery matters, and issued the following joint communique: (The Canadian and Portuguese delegations) "recognized that it was imperative to ensure strict fulfillment of obligations assumed under the International Commission for the Northwest Atlantic Fisheries (ICNAF), particularly in light of serious declines in the stocks." The Portuguese delegation indicated that they were taking measures to improve their fishing vessel log-book to bring about a fuller reporting of discarded by-catches, and that they would be intensifying their sampling program to improve the assessment of the state of the stocks and the yields they can support. It was agreed that, under the ICNAF Scheme of Joint International Enforcement, steps would be taken to enable Portuguese fisheries inspectors to work with Canadian inspectors in securing improved compliance with ICNAF regulations.

The Portuguese delegation announced the intention of their Government to designate in the near future a Portuguese fisheries official stationed in St. John's, Newfoundland. The representative would deal directly with Canadian fisheries authorities on a day-to-day basis, with regard to the implementation of conservation measures and their enforcement and other related matters.

It was agreed that officials of the two sides would meet from time to time, as needed to:

1) Review problems raised by either Government regarding the implementation of agreed measures, and to make recommendations for the resolution of such problems;

2) Facilitate the coordination of statistical and scientific information;

3) Improve bilateral cooperation on fisheries matters of mutual interest.

Both delegations attached great importance to their future cooperation in the field of fisheries. The Portuguese delegation stated that, as long as the conservation and rational utilization of the living resources of the sea are assured in the general interests of mankind, Portugal recognizes to Canada, as a coastal state, economic rights, in an area beyond and adjacent to waters now under its fisheries jurisdiction, in accordance with the consensus emerging from the third United Nations Conference of the Law of the Sea. The two sides expressed their readiness to meet at an early opportunity in order to consider the elaboration of a bilateral agreement of fisheries cooperation that would establish the terms and conditions governing continued fishing by the Portuguese fleet in waters off Canada's Atlantic Coast, taking into account anticipated legal and jurisdictional changes in the regime of fisheries management in such waters and relevant provisions of the 1972 Canada/Portugal fisheries agreement.

The Portuguese delegation was chaired by J.C.E. Cardoso, Director General, Fisheries General Administration; the Chairman of the Canadian Delegation was M.P. Shepard, Director, International Fisheries Policy, International Fisheries and Marine Directorate, Department of the Environment. (Source: U.S. Embassy, Ottawa.)

ROK Fishing Vessel Is Seized and Fined

Two National Marine Fisheries Service (NMFS) enforcement agents were aboard a U.S. Coast Guard C-130 aircraft on 7 August 1975, when they sighted the Republic of Korea (ROK) stern trawler *Kum Kang San* fishing in an area 10.5 miles off Sisters Island and 7.9 miles off Seal Rock, near Sanak Island, in the western Gulf of Alaska (see map), inside the U.S. Contiguous Fishing Zone (CFZ).

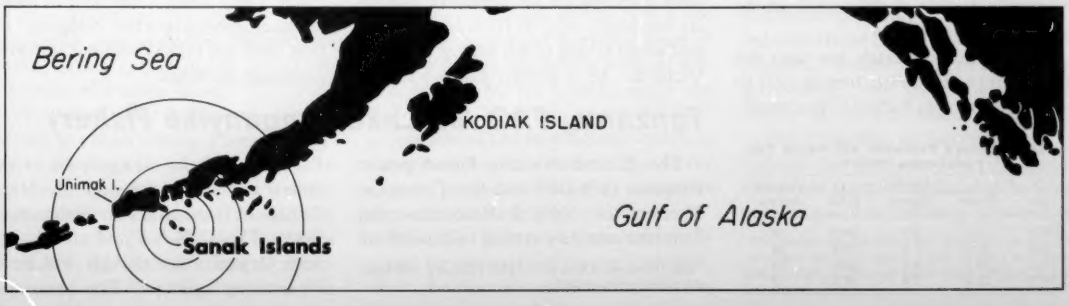
The aircraft notified the *Kum Kang San* by flashing light and message blocks to stop and await the arrival of the Coast Guard Cutter *Confidence*. The *Kum Kang San* retrieved its trawl and proceeded out beyond the CFZ where it stopped.

The *Confidence* seized the *Kum Kang San* on 8 August and escorted it to Kodiak, reaching that port on 10 August. The vessel was moored in Kodiak while the master of the fishing vessel and U.S. witnesses traveled to Anchorage to appear before the U.S. District Court. The master of the *Kum Kang San* was arraigned 13 August; he entered a plea of not guilty. The vice-president of the Korea Deep Sea Fishing Company (the owner of the fishing vessel) and the company's lawyers discussed an out of court settlement with the U.S. Attorney in Anchorage. The case was settled on 24 September. A criminal penalty of $8,000 was assessed against the master and a civil penalty of $407,000 was assessed the owner of the vessel. The *Kum Kang San* departed U.S. waters on 29 September.

According to the NMFS Office of International Fisheries, the *Kum Kang San* had been fishing off Alaska only since 27 July 1975, and had a total catch of 57 metric tons aboard. The catch, valued at approximately $14,800, was composed of Alaska pollock, sablefish, and red rockfish. The vessel is of Japanese construction, built in 1972, and is 186 feet long. Its estimated value is $2 million, for it appears to be in excellent condition.

The Republic of Korea entered the North Pacific fishery on a commercial basis in 1967. For reasons perhaps attributable to their inexperience in the fishery and their incomplete understanding of applicable U.S. laws, ROK fishing vessels were involved in several incidents between 1967 and 1970. The *Kum Kang San* is the second vessel apprehended for a violation of U.S. law since 1973.

In July 1973, the ROK stern trawler *Dong Bang No. 71*, owned by the Dong Bang Ocean Fisheries Company, Ltd., Seoul, was observed fishing 10.5 miles off Yakobi Island in violation of the United States CFZ. The Coast Guard Cutter *Clover* seized the fishing vessel and escorted it to Juneau, Alaska. A total of $90,000 in criminal and civil penalties were paid to the U.S. District Court. The *Dong Bang No. 71* departed Juneau 3 August 1973.



Kenya Seeks To Increase Fisheries Catch

Matthew J. Ogutu, Kenya's Minister of Tourism and Wildlife, stated during a reception for the Japanese Ambassador that Kenya currently has at its disposal enough experts and equipment to meet the domestic demand for fish, reports the NMFS Office of International Fisheries. He added, however, that the introduction of more modern technology would enable Kenya to further increase its fisheries catch. This is especially important as the "Eat More Fish" campaign, launched last year by the Government, has been successful in increasing the domestic consumption of fish.

The Minister also mentioned to Ambassador Ota that Japanese assistance, especially in providing vessels, could help develop Lake Victoria, Lake Naivasha, and Lake Baringo's fisheries as well as high-seas fishing off Kenya's coast near Mombasa.

The fisheries catch of Kenya increased from 12,600 metric tons in 1960 to 28,600 tons in 1974 (Fig. 1). In the

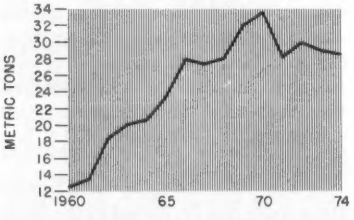


Figure 1.—Fisheries catch of Kenya, 1960-1974, from FAO Yearbook of Fishery Statistics and *Fishing News International*, July 1975.

1960's, the progress was continuous each year (except in 1967) and in some years the catch increased by as much as 10-20 percent. By 1970, Kenya's catches peaked at a record 33,700 tons. Since then, however, Kenya's fisheries catch has declined in 3 out of 4 years. The 1974 catch of 28,600 tons represented a decline of 400 tons from the 1973 catch.

Kenya's marine catch has also declined from 6,900 metric tons in 1971 to 3,400 tons in 1974 (Table 1). As a result, only 12 percent of Kenya's total catch came from marine fisheries in 1974. The major reasons for this decline have been inadequate market prices for marine species, the use of dynamite, and the failure of Kenya's marine fishermen to organize effective cooperative societies able to provide credit for the purchase of modern fishing gear.

Table 1.—Kenya's freshwater and marine fisheries catch, 1971-74.

Year	Catch			Percent marine
	Fresh	Marine	Total	
1971	21.3	6.9	28.2	24
1972	22.3	7.7	30.0	26
1973	25.0	4.0	29.0	14
1974	25.2	3.4	28.6	12

fishermen concentrate their operations along the shore, where, according to recent reports, serious overfishing may be taking place. Government officials report that fishing is now conducted in estuaries and bays (where the fish breed). Expanding fishing operations in previously underexploited Lake Rudolf (see map), however, have enabled Kenya to show a net gain in its freshwater fisheries catch.

Kenya, Tanzania, Lake Tanganyika, and neighboring nations.

The freshwater catch in Lake Victoria has stabilized in the past few years. The 15- to 20-foot long dugout canoes, used by Kenya's fishermen do not permit operations far from shore. Limitations imposed by the primitive canoes are especially serious from June to August when strong winds prevail on Lake Victoria. As a result, Lake Victoria

Kenya still imports some fishery products. In 1974, fishery imports totaled 3,567 metric tons. This is a 77 percent increase over 1973 when only 2,013 tons were imported. Fishery imports amounted to 15 million Shillings (US$2.1 million), equal to 43 percent of the total value of the 1974 domestic catch. Only about 1,400 tons of fishery products were exported, bringing 7 million Shillings (US$1 million) in foreign exchange earnings.

Tanzania, FAO Aid Lake Tanganyika Fishery

The United Nations Development Program (UNDP) and the Tanzanian Ministry of Natural Resources and Tourism[1] are cooperating to expand the fisheries of Lake Tanganyika to their fullest sustainable potential, the NMFS Office of International Fisheries reports. The U.N.'s Food and Agriculture Organization (FAO) will be the "executing agency." The project en-

[1]The Fisheries Division of the Ministry will have the direct responsibility.

tails UNDP contributions of US$1.4 million and a Tanzania contribution of 3.8 million shillings (equivalent to US$536,000).

Lake Tanganyika is the second largest lake on the African continent. Tanzania has sovereignty over almost one-half (13,600 km² of the 30,000-km² lake. After two decades of steady increases in production, the lake's fishery stocks—reportedly among the richest in East Africa—remain only lightly exploited. Although adequate information is lacking, a 1974 report indicated that the catch from the Tanzanian part of the lake (comprising the major share of the lake's fisheries catch) amounted to only about 25 percent of the lake's sustainable maximum yield estimated at over 200,000 metric tons per year. While these figures represent only "intelligent guesses" by fishery biologists, the disparity suggested between the estimated yield potential and the actual catch is substantial enough to indicate the possibility of a vigorous development of the lake's fisheries.

The long-range objectives of the project include exploring the possibility of fishing the unexploited parts of the lake and to improve catching, processing, and marketing techniques. Although there are two modern fish-processing enterprises at Kigoma as well as some villages which specialize in the catch of large fish, by far the largest portion of the catch consists of small clupeids known as "dagaa."

These herring-like fishes are mostly caught at night when they are attracted by light. There is a strong and growing market for dried dagaa in Tanzania and neighboring countries. The 1970 exports from Tanzania to Zambia are estimated at 22,000 metric tons (fresh weight equivalent). There is little doubt that vastly increased catches could be absorbed at attractive prices, provided the quality of the dried product could be improved.

The potential market for fish products is of special interest when one notes that in each of the four countries bordering the lake—Tanzania, Zaire, Burundi, and Zambia—protein deficiency is widespread.

Argentina Rejects Polish Joint Fish Venture Offer

A Polish fisheries delegation visited Argentina in January 1975 to discuss a joint-venture proposal made by the Board of Polish Fisheries. Under the Polish proposal Argentina would have to charter Polish fishing vessels and motherships as well as permit Polish organizations to market processed fish in Europe. The Poles would use Argentine ports for bunkering and resupplying of their fishing vessels. In return, the Fisheries Board offered to construct a modern fish-processing plant in either Puerto Deseado or Río Gallegos, both located in Santa Cruz Province. The proposal was considered unacceptable by the Argentine National Fisheries Service as well as by the Province of Santa Cruz, according to the U.S. Embassy in Buenos Aires.

The Polish News Service reports that Poland has been making a concerted effort to develop joint fishery ventures. In exchange for access to fishing grounds claimed by coastal states, Poland is offering to develop local fishing industries by supplying vessels, capital equipment, and expertise. The Poles are also seeking the use of ports for catch transshipments, vessel repairs, and air rotation of the crew. A portion of the catch would be landed in the coastal country, presumably for sale on local markets.

According to the NMFS Office of International Fisheries, Poland plans to continue expanding her fisheries into the 1990's when a catch of 2-3 million metric tons is being planned. By 1980, Polish fishermen are scheduled to catch 1.1 million metric tons—almost double the 1974 catch of about 600,000 tons—mostly by expanding their traditional Atlantic fisheries into the Pacific and Indian Oceans. This expansion will be made possible by adding to the existing Polish fishing fleet new stern factory trawlers built in Polish shipyards at the rate of two a month. In the 1950's and early 1960's, Poland delivered most of her new fishing and fishery support vessels to the Soviet Union; since the mid-1960's, however, a much larger proportion of the new fishing vessels is being built for the domestic fleet or for export to West European countries (France, Iceland, UK, etc.).

Poland's fishery expansion plans could be endangered by the establishment of wider national fisheries jurisdictions and by the possible adoption at the forthcoming Law of the Sea Conference of a 200-mile Economic Zone, where fisheries will be strictly regulated by the coastal states making it impossible for the high-seas fishing nations like Poland, USSR, East Germany, Japan, and others to obtain the same large catches as they used to in the past from adjacent grounds. Polish fishery officials have determined that the best solution to this problem is to develop joint ventures in those countries off whose coasts there are large resources of fish stocks.

Argentina, which proclaimed a 200-mile Territorial Sea in 1967 and kept all foreign fishing vessels out of its waters, rich with abundant resources of Patagonian hake and other species, was a primary target for East European fishing countries anxious to secure their sources of raw materials. Polish failure to obtain a joint venture in Argentina must be viewed as a setback in her long-term fishery development plans.

Russia and Singapore Okay Fishery Venture

Sovrybflot, the foreign trading branch of the Soviet Ministry of Fisheries, and Straits Fisheries, Ltd., a company that is partly owned by the Development Bank of Singapore, have agreed to set up a $12 million (Singapore dollars) joint fisheries venture, according to reports in Singapore's *Primary Production Bulletin* and on Radio Singapore.

Under an agreement signed in Singapore on 19 June 1975, a new seafood-processing firm called Marissco (Pte.[1]), Ltd. was to be formed. This company will not only process, but also package and sell on the international market various kinds of fish, lobsters, squid, cuttlefish, prawns and by-products, including fish meal. A large cold-storage plant will be built in the Jurong Port complex to provide processing facilities and warehouse space for fishery catches unloaded from Soviet trawlers. The two partners, Straits Fisheries Ltd. and Sovrybflot, will own the company jointly on an equal share (50-50) basis.

The President of Sovrybflot, S. A. Babaev, has mentioned that the venture will profit from being located in Singapore, a position half-way between the

[1]Pte. refers to the fact that Marrisco is a private company under English Law: it does not sell its shares to the public nor allow shareholders to transfer their holdings.

Indian and Pacific Oceans. The Soviet fishing fleet operates extensively in both areas.

The Jurong Fishing Port and Central Fish Market opened on 26 February 1969, replacing the old Fisheries Port Office at Telok Ayer Basin and two wholesale fish markets in the city of Singapore itself. The complex is designed to serve as the main fish landing and wholesale distribution point in Singapore for both foreign and domestic vessels. After an initial period of slow growth, the Jurong Port expanded rapidly. By 1973, six fish processing plants and one ice plant were in operation and eight additional processing plants were under construction.

Mozambique Sets New Shrimp Grades, Costs

On 21 June 1975 the Export Division of the Mozambique Department of Commerce established new grades and minimum fob prices for shrimp exports from Mozambique, which supersede those established on 3 November 1973.

All exportable shrimp from Mozambique whether headless or with heads-on, are divided into eight (formerly seven) grades or sizes as follows: Jumbo (Gigante), Extra Large (Grande 1), Large (Grande 2), Extra Medium (Medio 1), Medium (Medio 2), Extra Small (Pequeno 1), Small (Pequeno 2), and Very Small (Miúdo).

New prices are reflected in the following tables:

Table 1.—Minimum export prices (fob) for heads-on shrimp.

No. per lb	No. per kg	Grades	Code letters	Minimum prices
				US$/kg
Less than 6	Less than 13	Jumbo	TG	4.80
7 to 9	14 to 20	Extra large	G	3.40
10 to 12	21 to 26	Large	GG	3.40
13 to 15	27 to 33	Extra medium	M	3.00
16 to 18	34 to 40	Medium	MM	3.00
19 to 21	41 to 46	Extra small	P	2.40
22 to 24	47 to 53	Small	PP	2.40
25 to 42	54 to 92	Very small	X	2.00

Table 2.—Minimum prices (fob) for heads-off shrimp.

No. per lb	No. per kg	Grades	Code letters	Minimum prices
				US$/kg
Less than 10	Less than 22	Jumbo	TG	7.20
11 to 15	23 to 33	Extra large	G	5.00
16 to 20	34 to 44	Large	GG	5.00
21 to 25	45 to 55	Extra medium	M	4.40
26 to 30	56 to 66	Medium	MM	4.40
31 to 35	67 to 77	Extra small	P	3.60
36 to 40	78 to 88	Small	PP	3.60
41 to 70	89 to 154	Very small	X	3.00

Table 3.—Changes in minimum shrimp prices (fob), 1973-74, in U.S. dollars per kilogram.

	Heads-on		Heads-off	
Size of Shrimp	1974	1973	1974	1973
Jumbo	4.80	4.00	7.20	4.80
Extra large and large	3.40	2.80	5.00	3.68
Extra medium and medium	3.00	2.40	4.40	3.28
Extra small and small	2.40	2.00	3.60	2.80
Very small	2.00	2.00	3.00	2.80

Status of India's Fishery Resource Surveys Told

The Indian Government's Central Advisory Committee on Exploratory Fishing held its fifth meeting at Panaji, Goa, on 16 August 1975, the U.S. Consulate in Bombay reports. The meeting was presided over by P.C. George, Joint Commissioner, Union Ministry of Agriculture and Irrigation, New Delhi.

The pelagic fisheries project involving the survey of the continental shelf from Ratnagiri (150 miles south of Bombay) down to the southern tip of the west coast, covering part of Maharashtra, Karnataka, and Kerala states, for such marine resources as sardine and mackerel will be completed with United Nations Development Program (UNDP) assistance. The UNDP has agreed to extend the project deadline to March 1979 and will also bear the total cost of the survey, estimated at Rs. 25 million (US$3.3 million).

Negotiations are being held under the Indo-Polish Marine Fisheries Agreement for Polish assistance to survey seas north of Ratnagiri and along the coastline of Gujarat. With the conclusion of this agreement, the entire west coast will be brought under the pelagic fishery survey.

While the UNDP has agreed to consider providing assistance for the survey of the lower part of the east coast covering part of Andhra Pradesh and Tamil Nadu (Madras), the Indian Government is planning to bring the upper east coast (part of Andhra Pradesh, Orissa, and West Bengal) under the regional survey program of the Indian Ocean Survey, financed by the Swedish International Development Agency (SIDA).

To develop expertise in the construction of exploratory survey vessels, construction of two large deep-sea vessels was begun last year by the Goa Shipyard, a subsidiary of the government-owned Mazagaon Docks Ltd., Bombay. Part of the available Norwegian aid will buy components and shipbuilding expertise for this project. While urging the need for these fishery resource surveys, P.C. George also expected the U.N. Law of the Sea Conference to reach agreement on large exclusive fishing zones for coastal nations.

Whale Meeting Sets Provisional Quotas

Representatives from Japan, the Soviet Union, Brazil, and South Africa met in Tokyo, 14-15 August 1975, to determine catch quotas for certain whale species. The total world whale catch quotas for sei and minke whales were determined at the July 1975 meeting of the International Whaling Commission (IWC) in London. The purpose of the Tokyo meeting was to divide the total quotas for sei and minke whales in the Southern Hemisphere among the

countries harvesting whales there. Provisional quotas were set, but Brazil objected to them, demanding a larger share of the whale harvest for itself (Tables 1, 2). Negotiations continued through diplomatic channels.

Table 1.—Sei whale catch quotas for the southern hemisphere by country, 1974 and 1975.

Country	Number of whales		Percent change from 1974
	1974	1975	
Japan	2,392	1,331	−44%
USSR	1,608	895	−44
Brazil	3	4 (¹32)	+33 (¹+967)
S. Africa	—	—	—
Total[3]	4,003	[2]2,230	−44%

[1]Brazil's request for higher quota.
[2]Total catch quota set by the IWC in London, July 1975.
[3]Does not include whales caught by Peru.

Table 2.—Minke whale catch quotas for the southern hemisphere by country, 1974 and 1975.

Country	Number of whales		Percent change from 1974
	1974	1975	
Japan	3,500	3,017	−14%
USSR	3,500	3,017	−14
Brazil	765	642 (¹1,030)	−16 (¹+35)
S. Africa	117	134	+15
Total	7,882	[2]6,810	−14%

[1]Brazil's request for higher quota.
[2]Total catch quota set by the IWC in London, July 1975.

Table 3.—Japan's whale meat imports in 1974, by country of origin.

Country	Quantity (metric tons)	Percent of total
Soviet Union	18,572	65%
Iceland	3,016	11
Peru	2,508	8
Other n.s.	4,482	16
Total imports	[1]28,578	100%
Total domestic production	54,422	
Total consumption	80,000	

[1]This total was worth 4,557 million yen (US$15.3 million at 297 Yen = US$1.00). Source: Kyodo News Service.

The NMFS Office of International Fisheries reported that Japan had begun talks with the Soviet Union and other whaling nations to increase imports of whale meat to satisfy Japan's domestic demand, estimated at 100,000 metric tons in 1975. The Japanese consumed 80,000 metric tons of whale meat in 1974, but imports accounted for nearly a third of this total, or about 29,000 metric tons. Because of reduced whaling in the southern hemisphere, Japan's annual production of whale meat for 1975 is estimated at only 40,000 metric tons, 15,000 less than in 1974. Such companies as Taiyo Gyogyo and Tokyo Maruichi Shoji are hoping to import 19,000 metric tons of whale meat from the Soviet Union this year, an increase of 12,500 metric tons over the 1974 imports (Table 3). Nippon Suisan and Kyokuyo are planning to import whale meat from Iceland and South Africa.

France Reports 1974 Fisheries Statistics

The French Committee of Fisheries' annual fisheries statistics for 1974 have been reported by *Le Marin*. Landings of fish, crustaceans, and shellfish declined 1.4 percent from 569,300 tons in 1973 to 561,200 tons in 1974, but the value increased from 1.68 billion francs (US$420 million) to 2.002 billion francs (US$500 million), or by 19.2 percent. A large part of that increase must, however, be attributed to inflation.

Oyster farming was the highlight of 1974. The harvest of that mollusk increased from 72,000 tons in 1973 to 79,100 in 1974, while value rose to 649 million francs (US$162 million), or almost double the 1973 value of 384 million francs (US$96 million).

The 1974 deficit in the fisheries trade was 1.308 billion francs (US$325 million), almost 80 million francs (US$20 million) more than in 1973. However, in a favorable development, the ratio of exports to imports increased from 25.9 percent to 29.3 percent in 1974.

Although the fisheries trade amounted to only 0.72 percent of total French imports and 0.24 percent of exports, it accounted for 8.2 percent of the entire Franch trade deficit. The trade outlook for 1975 showed few signs of improvement. A complete table of French fishery landings is printed below.

Landings in metric tons and value in francs[1] of French maritime fisheries products, 1973-74.

Product	Landings			Value		
	1973	1974	Percent difference	1973	1974	Percent difference
Fresh fish	415,300	395,800	− 4.7	1,111.3	1,288.0	+ 15.9
Frozen fish	57,000	80,200	+ 40.7	184.3	322.6	+ 75.0
Cod, pollock, and other	20,600	29,200	+ 41.7	93.8	171.2	+ 82.5
Tropical tuna	31,400	46,700	+ 48.7	85.0	139.0	+ 63.5
Sardine	5,000	4,300	− 14.0	5.5	12.4	+125.5
Salted fish	6,600	5,700	− 13.6	24.0	35.7	+ 48.7
Crustaceans	29,300	29,400	+ 0.3	206.7	217.1	+ 5.0
Shell fish	43,600	35,600	− 18.3	108.4	97.9	− 9.7
Cephalopods	14,600	9,500	− 34.8	37.8	31.5	− 16.7
Tunicates and sea urchins	600	700	+ 16.7	2.0	2.3	+ 15.0
Fish meal	2,200	4,100	+ 86.4	5.4	7.0	+ 29.6
Fish oil	100	200	+100.0	0.1	0.3	+200.0
Total	569,300	561,200	− 1.4	1,680.0	2,002.4	+ 19.2
Oyster culture	72,000	79,100	+ 9.9	384.0	649.0	+ 69.0
Mussel culture	41,000	39,000	− 4.9	57.4	57.7	+ 0.5
Seaweed	13,700	10,200	− 25.5	6.1	5.6	− 8.2
Total volume of marine fisheries trade				2,127.5	2,714.7	+ 27.6

[1]US$1.00 = 4.005 francs.

Canada, USSR Form Consultative Commission

Canadian and Soviet delegations met at Ottawa 25-27 August 1975 to discuss fishery matters of mutual concern, and agreed to initiate the formation of a "Joint Fisheries Consultative Commission" and to establish "new methods of cooperation." The closure of Canada's Atlantic ports to Soviet vessels on 28 July precipitated the talks, and Canada has agreed to reopen its ports if the Soviets cooperate in protecting fishery resources off Canada's coasts as they have promised in these recent discussions.

Specifically, the Canadians and the Soviets agreed to adhere strictly to ICNAF (International Commission for the Northwest Atlantic Fisheries) measures and quotas; this was one of the key issues which caused the Canadians to close their ports. Both sides also agreed to coordinate statistical and scientific information, to improve bilateral cooperation under the ICNAF

Joint International Enforcement Scheme, and to cooperate more closely on problems of gear damage and the settlement of claims advanced by Canadian fishermen. Finally, the two governments agreed to promptly discontinue fishing when the national quota for a fisheries stock has been taken.

Both sides reviewed the Canadian proposals for the conservation and management of fishery stocks off Canada's Atlantic coast and scheduled further discussions at the Special ICNAF Meeting which was held in Montreal during the last week in September. The Soviet delegation was headed by Aleksei A. Volkov, Deputy Chief of the External Relations Department, Ministry of Fisheries, and the Canadian delegation by L.H. Legault, Director General, International Fisheries and Marine Directorate, Department of the Environment. (Source: Communique, Canadian Department of External Affairs.)

The NMFS Office of International Fisheries notes that the Canadians have received pledges of cooperation from the Soviets in several important areas and have taken initial steps toward a bilateral agreement on fisheries cooperation. By recommending the formation of a "Joint Fisheries Consultative Commission," the Canadian Government is establishing a means of addressing its complaints and protests to the proper Soviet channels. In addition, the Canadians and the Soviets have agreed to develop procedures to standardize catch information on which implementation of quotas is based.

CSFR Violation Trips Cuban Factory Trawler

The U.S. Coast Guard seized on 17 August the *Playa de Verdadero*, a 270-foot, *Atlantik*-class stern factory trawler, built for Cuba in East Germany. The seizure took place 55 miles east of Cape Cod, Mass. by the Coast Guard cutter *Vigorous* for a Continental Shelf fisheries resource (CSFR) violation. The *Playa de Verdadero* attempted to evade boarding attempts by ignoring signals to stop. Once aboard the Cuban vessel, the U.S. inspection team found lobster parts in various locations; the Coast Guard described the crew's attitude as uncooperative. The Cuban vessel was escorted to Boston.

The Captain, Ivan Ishchenko and 5 other crew members were found to be Soviet citizens. The presence of the Soviets aboard Cuban vessels is not unusual. Under the current fisheries agreement, the Soviet Union is obligated to train a certain number of Cuban fishermen and navigators in return for the use of the Havana fishing port and for other privileges.

Due to the small amount of lobsters found on board, the civil suit against the vessel was withdrawn and the criminal charges against the captain were dismissed. On 23 August, the *Playa Verdadero* departed U.S. waters under a Coast Guard escort.

According to the NMFS Office of International Fisheries, the *Playa de Verdadero* was the seventh foreign fishing vessel seized by the U.S. Coast Guard since January 1975, for a CSFR violation[1]. The seizures are based upon the Bartlett Act which prohibits foreign fishermen from taking lobster and other protected shellfish on the U.S. Continental Shelf. The Bartlett Act was enacted in 1964, but the law was enforced only against foreign fishermen who were intentionally taking protected shellfish. The new, stricter enforcement guidelines, require not only that lobster taken as an incidental catch be returned to the sea, but that foreign vessels reset their trawl in a different location when an "area of concentration" of lobsters is encountered. The Act provides for fines of up to $100,000 and/or imprisonment of up to one year. Additionally, the vessel, her gear, and her catch are liable to forfeiture. Most cases, however, are settled out of court. Such court-approved settlements have provided for fines ranging from $25,000 for an Italian vessel caught with 25 pounds of lobsters to $425,000 for a Bulgarian vessel which had nearly 500 pounds of lobsters on board.

The presence of the Cuban trawler off Boston is an indication of growing Cuban interest in the ICNAF fisheries. Three Cuban vessels have fished there so far this year, the first time since 1972. The Cubans have indicated that as many as 15 Cuban vessels may fish in the ICNAF area in 1976. The expansion of the Cuban high-seas fleet provides Cuba with the potential to expand their efforts in ICNAF. In July, a new Spanish-built trawler arrived in Havana, bringing the Cuban high-seas fleet to 24 trawlers and 4 refrigerated transports. Press reports indicate that 24 more trawlers are currently under construction in Spain.

[1]An additional five foreign vessels have been seized within the U.S. 12-mile fishery limits where fishing by foreign vessels is prohibited.

Soviet Vessel Seized for CSFR Violation

The *Zaraysk*, a Soviet stern factory trawler, was seized 17 August for a Continental Shelf Fisheries Resources (CSFR) violation and taken to Governor's Island, N.Y., the NMFS Office of International Fisheries reports. The vessel was squid fishing about 80 miles off the coast of New Jersey when it was seized by the U.S. Coast Guard for an incidental catch of 25 pounds of red and stone crabs which were not returned to the sea. A U.S. Government civil forfeiture action was filed against the vessel, but on 29 August a settlement was reached and the *Zaraysk* departed Governor's Island. Analysis by NMFS laboratories of fish meal found aboard vessel has not revealed a significant amount of shellfish fragments.

The *Zaraysk* was also served with a $50,000 writ of attachment for damage done by the Soviet fishing trawlers to fixed U.S. lobster gear. The plaintiff in that private suit is Cormier Fisheries Company of Montauk, Long Island. Although this attachment was removed after attorneys representing the Soviet Fishing Fleet (Sovrybflot) posted a letter of indemnity, final settlement of the case is still pending.

Under the Bartlett Act, U.S. Code 1081-1086, a vessel seized for a CSFR violation is subject to forfeiture together with its gear and cargo. In addition, the captain of the vessel can be personally fined up to $100,000, or be imprisoned for up to one year, or face both fine and imprisonment. The prosecution of the *Zaraysk*'s captain has been deferred for one year, although the forfeiture was settled with the payment of the $100,000 fine.

Taiwan Fishing Industry Reports Gradual Recovery

Taiwan's fisheries catch totaled 366,000 metric tons during the first half of 1975, an increase of 9.7 percent over the comparable period in 1974, reflecting the gradual recovery of Taiwan's fishing industry, according to the *China Post*. The Provincial Fisheries Bureau set the target for this year's total catch at 750,000 metric tons and the first half year's results represent 48.8 percent of the target. Deep-sea fishing topped the list with 164,000 metric tons. Inshore fishing ranked second with 138,000 metric tons, followed by fish culture with 9,000 metric tons and coastal fishing with 15,000 metric tons.

Taiwan is expected to export 7,500 metric tons of eels this year, earning over US$70 million in foreign exchange. By early August some 5,000 metric tons had already been exported, mainly to Japan. The price of eels is also higher than in 1974. The present export price is US$6.50 per kilogram, compared with US$5.00 in 1974. Taiwan has eel ponds totaling about 3,000 acres. In 1974, 6,800 metric tons of eels worth US$42 million were exported.

The Joint Commission on Rural Reconstruction (JCRR) and the Food Industry Research Institute will study the possibility of using microwave energy to maintain the freshness of shrimp. In the meantime, the JCRR will continue to give loans to fishermen for installation of refrigeration equipment on their shrimp vessels. Borax, to preserve shrimp freshness, has been banned by Taiwan.

Denmark Objects to NEAFC Herring Cuts

The Government of Denmark filed objections on 27 August, with the Northeast Atlantic Fisheries Commission (NEAFC), on the issues of herring quotas and minimum mesh size, the U.S. Embassy in Copenhagen reports. The Danish note said that its North Sea and Skagerrak quota of herring for human consumption of 69,000 metric tons (including the Faroes) for the period of 1 July 1975 to 31 December 1976 was unacceptable both in an absolute sense and also in relation to herring quotas which other NEAFC members have been allocated. Denmark stressed its concern for North Sea herring stock by pointing to its acceptance of a ban on the fishing of herring for reduction. The Danish Government suggested that quotas be renegotiated at the special NEAFC meeting in November.

Until resolution of the matter, the Danes vowed to maintain the prohibition issued on 10 July 1975 on directed fishing of herring for reduction and have set a limit on herring for human consumption at 45,000 metric tons for Denmark and 8,000 tons for the Faroes for the period of 1 July 1975 to 31 December 1975.

The Danish note also objected to the NEAFC recommendation for a 20 mm (0.8-inch) minimum mesh size claiming the recommendation was hastily drafted and did not include the normal transition time to phase out old nets. The Danes also claimed the regulation would prevent fishing for certain species.

According to the NMFS Office of International Fisheries, the reduction industry accounts for about 45 percent by value of the total Danish catch, and the NEAFC recommendations are thus affecting a large sector of the fishing industry. In 1974, Danish fishermen landed 24,000 tons of herring for human consumption and 155,000 tons for reduction: a quota of 69,000 tons for 18 months is a definite restriction.

Japan's 1974 Marine Fish Catch Declines

Data compiled by the Japanese Agriculture and Forestry Ministry's Statistics and Information Division show that marine fisheries catch during January-December 1974 totaled 9,636,000 metric tons, a decrease of 15,700 tons or 2 percent from 1973. Significant gains were recorded for jack mackerel, shrimp, yellowfin tuna (young), and Pacific mackerel, while sharp declines occurred in saury and yellowtail, among other species.

The most important species landed, in terms of quantity, was Alaska pollock, with a catch of 2,825,000 metric tons. However, compared with 1973, landings were down by 196,000 tons or 6 percent. Second in importance was Pacific mackerel, with 1,294,000 tons, up 159,000 tons or 14 percent above 1973.

Tuna (excluding skipjack) landings were 358,000 metric tons. Landings since 1970, the year when a low of 291,000 tons was reached, began to increase annually by over 10,000 tons, recording 308,000 tons in 1971, 318,000 in 1972, and 343,000 tons in 1973. Skipjack tuna landings, which totaled 347,000 tons, were 8 percent ahead of the 1973 catch of 322,000 tons and up 56 percent over the 223,000 tons for 1972.

Sources: *Suisan Tsushin*, and *Suisan Keizai Shimbun*, and others.

Japan's 1974 and 1973 marine fisheries catch of selected species.

Species	Catch		Comparison
	1974	1973	1974 over 1973
	1,000 metric tons		*Percent*
Alaska pollock	2,825	3,021	94
Pac. mackerel	1,294	1,135	114
Sardine	725	731	99
Saury	135	406	33
Flatfish	348	380	92
Jack mackerel	253	183	138
Tuna			
Skipjack	347	322	108
Bigeye	114	105	109
Albacore	98	95	103
Yellowfin	75	76	99
Bluefin	47	49	96
Yellowfin	24	18	133
Salmon	134	136	99
Rockfish	111	101	110
Herring	84	83	101
Shark	41	42	98
Squid	478	486	98
Crab	84	78	108
Shrimp	78	62	126
Sea urchin	24	26	92
Mollusk	309	261	118
Seaweed	198	221	90

EEC Extends Pollock, Cod Export Subsidies

The European Economic Community is continuing its export subsidies on cod and pollock (saithe and coalfish) fillets, according to Regulation (EEC) No. 2440/75 of the EC Commission, dated 25 September 1975. As of 1 October 1975 the subsidy is 8 Units of Account (UA) per 100 kg (net) for cod and 6 UA for pollock. This is about 4.4 and 3.3 cents per pound respectively at current exchange rates. (Source: US Embassy, Copenhagen.)

Canadian Fishermen Win Soviet Claims Settlement

The Soviet Government last fall settled several claims of Canadian lobstermen for approximately C$130,000, according to the U.S. Consulate in Halifax, Nova Scotia. The lobstermen claimed that the Soviet fishing fleet had destroyed or damaged the

Canadians' gear while conducting their own trawling operations.

Claims filed by October 1975 totalled $400,000, and some remained unsettled. Additional claims had been submitted since the negotiations began, and the Soviets agreed to "examine" additional claims submitted by Canadian fishermen. The negotiations were held in Halifax, Nova Scotia.

Australia Regulates Rock Lobster Fishery

Commercial catch statistics and catch samplings in 1972 showed that annual catches of rock lobster, particularly in Tasmanian waters, had reached a stage where they were almost wholly dependent on the annual recruitment from undersized stocks. It is possible that this factor was partially responsible for the decrease in Western Australian rock lobster catches within the past two years.

New standards were set on the minimum lengths of rock lobsters caught in southern and western Australian waters in an effort to prevent the depletion of juvenile lobster stocks. The new legal size, measured as the total carapace length, is 110 mm for male and 105 mm for female rock lobsters in Tasmania, and 100 mm for all "southern" rock lobsters from the waters off Southern and Western Australia. Previous minimum lengths were measured as rostral carapace length. (The above regulations are in metric units because on 1 November 1974 Tasmania changed from the so-called British imperial measuring system to the metric system.)

The new method of measuring carapace length has been used by research scientists for many years. Its legal application to Australian commercial fisheries will prevent the evasion of legal requirements through the willful breaking off of rostral horns from caught lobsters.

Most Australian lobster catches are exported because of high overseas demand resulting in high prices. Over 95 percent of all exports are "lobster tails" shipped to the United States. During the 1973-74 season, the value of Australia's lobster tail exports decreased by 15 percent below that of the previous year (from $30.2 million to $25.9 million).

The remaining 10 percent of lobster exports were "whole lobsters" shipped mostly to Japan (53 percent of all "whole lobster" exports, or about 200 metric tons). The traditional Australian exports of "whole lobsters" to France were neglible largely because the Cuban government sells its spiny lobster there at a lower price.

Sources: *Tasmanian Fisheries Research* and *Australian Fisheries.*

Fishery Notes

Alaska's 1975 Salmon Catch Best in 3 Years

Alaska's 1975 salmon catch—25.6 million fish—was the largest in three years despite depressed fisheries in several areas, the Department of Fish and Game has announced. The catch surpassed the near-record low harvests of 22.3 million in 1973 and 21.9 million in 1974 and exceeded the preseason forecast of 19.0 million fish.

Good escapements of Bristol Bay sockeye, record chum catches and escapements in the Arctic-Yukon-Kuskokwim region, and strong showings of pink salmon in Prince William Sound and lower Cook Inlet were highlights of the salmon season. Low catches in the Kodiak area and near-record lows in southeastern Alaska, the Chignik area, and the south side of the Alaska Peninsula combined to reduce the statewide total.

Southeastern Alaska had one of its poorest seasons since the turn of the century. Sockeye, coho, and chum salmon runs, expected to offset the predicted poor return of pink salmon, also produced some of the lowest catches on record. In contrast, pink returns in southern southeastern Alaska exceeded escapement requirements and 3.1 million pinks were harvested. With good survival, the southern pink escapement, 4.5 million, could well produce a strong return in 1977. The pink return to northern southeastern Alaska was weaker than anticipated, and only 0.6 million salmon were harvested from isolated areas where escapement goals were reached. Pink salmon escapement there is estimated at 1.5 million, about 2.5 million short of the goal. The Yakutat red salmon harvest was also below average[1]. Total catch for all salmon species in the southeastern and Yakutat areas was 5.3 million compared to an average of 12.8 million.

A strong early pink salmon run to Prince William Sound produced the largest catch there since 1971, and the pink salmon escapement goal there was met. Chum returns, however, were lower than expected. The Copper River king (chinook) salmon catch was about average, but poor sockeye and coho catches brought the total catch to less than half of average. The total Bering River catch was also less than half of average. The total area catch, 5.2 million, was above the 5-year 3.9 million fish average.

A strong pink salmon run in lower Cook Inlet, combined with above-average coho and chum catches, produced the largest harvest there since 1970. Pink escapement goals were reached in all lower Cook Inlet streams, but sockeye escapements lagged in the major Kenai Peninsula river systems. Total catch was 3.3 million compared to a 2.2 million fish average.

The Kodiak catch was depressed for the fourth consecutive year. Because of a poor red salmon run, there were no openings for sockeye and the incidental sockeye catch of 136,300 was the lowest since 1882. Despite the complete closure, overall escapement goals were not achieved in any of the major sockeye systems. The pink salmon catch was the highest since 1971, and the total return of 3.7 million was above the pre-season forecast of 3.0 million. Pink salmon escapement was also good, but chum salmon catch and escapement were weak. Total Kodiak catch was 3.2 million salmon.

The Chignik fishery produced one of the smallest salmon catches in recent years. Early Black Lake sockeye escapement lagged at 309,000 versus a goal of 400,000 despite complete closure of the fishery. The later Chignik Lake red salmon run was considerably stronger, with the escapement goal of 225,000 being reached. Almost 400,000 late-run reds were harvested. Pink and chum salmon catches and escapements

[1]In this report, "average catches" refer to those of 1970-74.

were very poor. Total catch for the Chignik area was 544,000 salmon.

The red salmon catch at South Unimak and the Shumagins was limited to a total harvest of 233,000 fish. A generally weak showing of pinks and chums along the South Peninsula resulted in few openings and poor catches. However, escapements were fairly good for both species. The total South Peninsula catch was 406,000. Aleutian returns were generally weak and no fishery occurred in the area. The last fishery there was in 1973 when 2,768 pink salmon were taken. On the north side of the Alaska Peninsula, red salmon escapement goals were achieved in the Bear and Sapsuck river systems and the sockeye catch of 232,000 was close to the average of 235,000. The chum return was poor, but coho catch and escapement were good.

Bristol Bay experienced a very weak peak year with 4.8 million sockeye harvested from a total run of 24.1 million. Escapement goals were attained or exceeded in all major Bay systems this year. With average natural survival, the total Bay escapement of 19.3 million, coupled with the 1974 escapement of 9.6 million, could produce bumper runs in 1979 or 1980. Record chum catches were made in the Norton Sound, Yukon and Kuskokwim districts and the Kotzebue chum harvest was second only to the record 1974 catch. Escapements were also some of the largest ever observed. King salmon catches were below average on both the Yukon and Kuskokwim rivers. Final chum catch for this region was 2.0 million and total catch was 2.2 million.

Publications

New NMFS Scientific Reports Published

The publications listed below may be obtained from either the Superintendent of Documents (address given at end of title paragraph on affected publications) or from D825, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Writing to the agency prior to ordering is advisable to determine availability and price, where appropriate (prices may change and prepayment is required).

NOAA Technical Report NMFS SSRF-689. French, Robert R., Richard G. Bakkala, and Doyle F. Sutherland. "**Ocean distribution of stocks of Pacific salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdnerii*, as shown by tagging experiments. Charts of tag recoveries by Canada, Japan, and the United States, 1956-69.**" June 1975. 89 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

ABSTRACT

Extensive tagging experiments by member nations of the International North Pacific Fisheries Commission—Canada, Japan, and the United States—have been conducted in offshore waters of the North Pacific Ocean to investigate the ocean distribution of stocks of Pacific salmon, *Oncorhynchus* spp. This effort has resulted in the recovery of 15,215 tags including steelhead trout, *Salmo gairdnerii*, from inshore and high-seas areas. To provide a reference by which the offshore distribution of the various stocks can be readily seen as shown by tagging results through 1969, the tagging locations at sea are illustrated for each species and recovery area.

NOAA Technical Report NMFS SSRF-684. Nicholson, William R. "**Age and size composition of the Atlantic menhaden, *Brevoortia tyrannus*, purse seine catch, 1963-71, with a brief discussion of the fishery.**" June 1975. 29 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

The catch of Atlantic menhaden, *Brevoortia tyrannus*, estimates of numbers of fish caught by age, fishing effort, age and size distribution, and changes in the fishery are summarized and briefly discussed for the five areas of the Atlantic coast of the United States for 1963-71. Appended are tables of seasonal length frequency distributions and mean lengths by age and port and tables of monthly mean lengths by sex, age, and port. The purse seine fishery declined after 1962. North of Chesapeake Bay, plants closed or reduced fishing as fish became scarce. Of eight plants that processed menhaden in 1962 only two operated in 1971. The catch and catch per unit of effort in Chesapeake Bay declined as effort increased. South of Cape Hatteras, N.C. the fishery, which had been small compared to the fishery in other areas, showed little change. The average age and size of fish in the total catch declined as the fishery north of Chesapeake Bay, which mainly caught older and larger fish, declined. Age-1 and -2 fish, which constituted most of the catch from Florida to Chesapeake Bay, increased in average length and weight.

NOAA Technical Report NMFS CIRC-391. Damkaer, David M. "**Calanoid copepods of the genera *Spinocalanus* and *Mimocalanus* from the central Arctic Ocean, with a review of the Spinocalanidae.**" June 1975. 88 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

The family Spinocalanidae includes small to medium-sized marine calanoid copepods belonging to the genera *Spinocalanus*, *Monacilla*, *Mimocalanus*, and *Teneriforma*. All species are deep-living and often comprise a large proportion, or even a majority, of the copepods in deep samples. In spite of their prevalence, definitive knowledge of the Spinocalanidae has lagged behind that of other copepod groups because adequate collections from deep water have been few, and specimens from widely separated localities have seldom been compared. Most important, however, is the fact that the fragility of the specimens makes them very difficult to study; most investigators attempting to describe or identify Spinocalanidae have indicated that their specimens were damaged and incomplete.

The present study is based on collections of zooplankton from Fletcher's Ice Island, T-3, in the Canadian Basin of the Arctic Ocean in 1967-68. The seven species of Spinocalanidae from these collections are redescribed, and their vertical distributions are discussed, based on series of samples from discrete depth intervals to 3,000 m.

The systematics of the Spinocalanidae has been reconsidered, using characters in addition to those most commonly lost in sampling. All published descriptions and records are discussed. Several critical type specimens and specimens forming the bases of widespread records have been examined and are redescribed. Keys to the genera and all of the species have been prepared, with the goal of enabling an investigator to identify even damaged specimens. Many named species or forms have been placed in synonymy, and two new species (*Spinocalanus terranovae* and *Mimocalanus heronae*) are described. The family is now considered to comprise 32 species, distributed as follows: *Spinocalanus* (19), *Monacilla* (4), *Mimocalanus* (8), and *Teneriforma* (1).

NOAA Technical Report NMFS SSRF-675. Shomura, Richard S., and Francis Williams (editors). "**Proceedings of the International Billfish Symposium, Kailua-Kona, Hawaii, 9-12 August 1972. Part 3. Species synopses.**" June 1975. 159 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(No abstract)

NOAA Technical Report NMFS SSRF-691. Smith, W. G., J. D. Sibunka, and A. Wells. "**Seasonal distributions of larval flatfishes (Pleuronectiformes) on the continental shelf between Cape Cod, Massachusetts, and Cape Lookout, North Carolina, 1965-66.**" June 1975. 68 p.

ABSTRACT

Larval flatfishes, representing 4 families, 17 genera, and 15 species, were identified from collections taken during a 1-yr survey designed to locate spawning grounds and trace dispersion of fish eggs and larvae on the continental shelf. Most flatfishes began spawning in the spring, a time of marked seasonal temperature change. The seasonal distribution of larvae indicated that: 1) bothids had longer spawning seasons than pleuronectids; 2) pleuronectids spawned largely in the northern half of the survey area during the spring; 3) most bothids spawned in the southern half, beginning in spring and continuing through early fall; 4) although cynoglossids spawned incidentally off North Carolina, most of their larvae were transported into the survey area from spawning grounds south of Cape Lookout; 5) the few representatives of the family Soleidae originated south of Cape Lookout; 6) spawning that began in the spring proceeded from south to north as the season progressed, but spawning that began in the fall proceeded from north to south, suggesting that the onset of spawning is triggered by spring warming and fall cooling; 7) most species spawned within a relatively narrow range of temperature; 8) salinity had no apparent influence on spawning.

NOAA Technical Report NMFS SSRF-690. Straty, Richard R. "**Migratory routes of adult sockeye salmon, *Oncorhynchus nerka*, in the eastern Bering Sea and Bristol Bay.**" April 1975. 32 p.

ABSTRACT

The stocks of sockeye salmon, *Oncorhynchus nerka*, in Bristol Bay, Alaska, are produced in the lakes and streams of 10 major river systems, which discharge into the bay over a shoreline distance of 193 km.

The establishment of fishing areas, the determination when fishing may be permitted, and the effect of exploiting simultaneously several stocks of sockeye salmon require knowledge of the migratory pattern of the individual stocks comprising the run to Bristol Bay during spawning migration. Various mark-and-recapture experiments and exploratory fishing in the eastern Bering Sea and Bristol Bay provide a picture of the migratory pattern of Bristol Bay sockeye salmon from approximately long. 170°W to the head of Bristol Bay.

The main migration route of all stocks of Bristol Bay sockeye salmon is in the offshore waters of the southern half of the entrance to the bay and in the southern half of the bay itself. All stocks remain in the offshore waters until within 32 to 80 km of their home-river systems. Segregation according to river of origin apparently began in the offshore waters as much as 200 km from the mouths of the home-river systems and appeared to progress to the head of Bristol Bay.

NOAA Technical Report NMFS SSRF-693. Bakun, Andrew. "**Daily and weekly upwelling indices, west coast of North America, 1967-73.**" August 1975. 114 p.

ABSTRACT

Daily and weekly indices of intensity of large-scale wind-induced coastal upwelling at selected locations along the west coast of North America are presented for the 7-yr period, 1967-73. The indices are based on 6-hourly computations of the offshore component of Ekman transport using the synoptic surface atmospheric pressure analyses produced by the Fleet Numerical Weather Central to estimate the sea surface stress. The magnitude of offshore transport is considered an indication of resultant upwelling through the bottom of the Ekman layer. A spatial distortion in absolute magnitude results in noncomparability of numerical values between different locations.

NOAA Technical Report NMFS SSRF-694. Korn, Sid. "**Semiclosed seawater system with automatic salinity, temperature, and turbidity control.**" September 1975. 5 p.

ABSTRACT

The new seawater system at the Southwest Fishery Center, Tiburon Laboratory, is described. The system delivers up to 450 l/min of filtered, ultraviolet sterilized, temperature- and salinity-controlled seawater suitable for extended holding of marine fish and invertebrates. Unique aspects of the system including provisions for open and/or closed circulation, and the pneumatic salinity control components are described in detail. The design of this facility may offer ideas to others desiring near-oceanic quality seawater from marginal sources.

NOAA Technical Report NMFS SSRF-695. Matsumoto, Walter M. "**Distribution, relative abundance, and movement of skipjack tuna, *Katsuwonus pelamis*, in the Pacific Ocean based on Japanese tuna longline catches, 1964-67.**" October 1975. 30 p.

ABSTRACT

Catch data of the Japanese tuna longline fishery from 1964 to 1967 were analyzed to determine the distribution, abundance, and movement of skipjack tuna, *Katsuwonus pelamis*, in offshore waters of the Pacific Ocean.

Large skipjack tuna, as well as larvae, were found to be concentrated mainly in the east central equatorial Pacific. Movement of skipjack tuna stocks was determined by following the shifting of high-CPUE (catch per unit effort) cells from one quarter to the next. The apparent movement of skipjack tuna stocks in the Pacific appeared to coincide with the circulation of the major ocean currents; counterclockwise in the southern hemisphere and clockwise in the

northern hemisphere, except in the eastern Pacific where the current flow is counterclockwise. The movement patterns of high CPUE suggested that skipjack tuna adults or their progeny could move from one area to the next. The movement pattern was used also to determine the probable migratory routes followed by skipjack tuna tagged in the eastern Pacific and recovered near the Hawaiian and Christmas islands.

NOAA Technical Report NMFS CIRC-392. Thorson, Lee C., and Mary Ellen Engett. "**Fishery publications, calendar year 1974: Lists and indexes.**" June 1975. 27 p.

ABSTRACT

The following series of fishery publications of the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, in calendar year 1974 are listed numerically (with abstracts) and indexed by author, subject, and geographic area: NOAA Technical Report NMFS CIRC (formerly Circular); Data Report; Fishery Facts; NOAA Technical Report NMFS SSRF; and NOAA Technical Memorandum NMFS.

NMFS Lists New and Old Foreign Fisheries Leaflets

A new Foreign Fisheries Leaflet (75-1) Fisheries of Panama, 1973, is available for distribution. The 23-page leaflet contains information on artisanal fisheries, the shrimp, lobster, anchovy, herring, sardine, and scallop fisheries, industry developments, fisheries trade, vessel construction, fisheries investments, and international fisheries relations. If interested in obtaining a copy, request from: Office of International Fisheries, F41, National Marine Fisheries Service, NOAA, U.S. Department of Commerce, Washington, DC 20235. Please enclose a self-addressed label to facilitate the mailing.

The Office of International Fisheries also has a limited supply of a number of back issues of Foreign Fisheries Leaflets. Anyone interested in receiving a copy may order them from the following address: to: Division of International Fisheries Analysis (F41) Office of International Fisheries, NMFS, NOAA, Commerce, Washington, DC 20235. Requests will be honored as long as the supply lasts. Please enclose a self-addressed envelope (or a pre-addressed label) to facilitate mailing.

Foreign Fisheries Leaflets (by number and title) still available, include the following: 4A, Marine Fisheries of West Pakistan; 5, Denmark's Fishing Industry (1970); 26, Industrial Outlook Report of the Taiwan Fishing Industry, 1969; 35, Greece: Production of Processed Fishery Products, 1970; 52, North Portugal's Sardine Industry, 1969; 56A, Norway: Fishery Landings, 1967-1970; 79, Marine Fisheries of Nigeria, 1970; 91, Trends in Malaysian Fishing, 1968-1969; 120, Fisheries of the Democratic Republic of the Congo; 130, The Fisheries of Belem, Brazil, 1971; 149A, British Honduras Fish Exports, 1969; 150, The Fisheries of Equatorial Guinea, 1970; 156, World Fish Meal and Oil Review, 1969, and the Outlook for 1970; 161, Man-in-the-Sea Program in Japan, 1971; 165, The Marine Fisheries of Gabon, 1970; 172, The Shrimp and Spiny Lobster Industry, Bay Islands, Honduras, 1968; 181, Market Potential for Frozen Herring in West Germany, 1970; 182-A, Newfoundland Fisheries, 1970; 189, Canada's Fisheries Closing Lines, 1971; 72-3, The Developing Common Fisheries Policy of the EEC, 1972; 72-6, The Commercial Fisheries of Portugal, 1970; 72-11, Thailand Fishery Trends, 1972; 72-13, Fisheries of Sierra Leone, 1970-1971; 72-17, Fisheries of Taiwan, 1971; 73-1, Shrimp Industry of Central America, Caribbean Sea, and Northern South America; 73-2, Fisheries of Iceland, 1971; 73-3, Fisheries of the Republic of Korea, 1971; 73-8, Fisheries of Panama, 1971-72; 73-9, Fisheries of New Zealand, 1971; 73-10, Shrimp and Lobster Industry of Honduras; 73-12, Marine Fisheries of the Federal Republic of Germany, 1970-1971; 73-13, Fisheries of Venezuela, 1970-71; 73-14, North East Atlantic Fisheries, 1970; 73-15, Marine Fisheries of Norway, 1972; 73-16, Review of the Indonesian Shrimp Fishery, and its Present Developments; 73-17, Fishing Industry of Iceland, 1972; 73-18, Fishing Industry of Ireland, 1972; 73-19, Fisheries of the Ivory Coast, 1972; 73-20, Fishing Industry of Denmark, 1972; 74-3, Fisheries of the Gambia, 1973; 74-7, Japan's Frozen Shrimp Imports, 1964-73; 74-8, Fisheries of Denmark, 1973; 74-9, Fisheries of Tanzania, 1972; 74-10, Fisheries Statistics of Japan, 1972; 74-12, Fisheries of the Cameroons, 1973.

Third Baltic Symposium Proceedings Are Printed

Proceedings of the Third Baltic Symposium on Marine Biology, Helsinki/Helsingfors June 11th-17th, 1973, Merentutkimuslaitoksen Julkaisu, Havsforskningsinstitutets Skrift N:o 239, edited by Ake Niemi. Institute of Marine Research, Box 14166, Helsinki 14, Finland, 1975; 355 pp., illus.

The Third Baltic Symposium focused on two topics: 1) Production, food webs, and ecological models of the Baltic and 2) Indicator organisms/communities of different environments in the Baltic. The papers on these two topics covered many aspects from pure science to applied investigations. One day of the meeting was devoted to reports of the Baltic Marine Biologists working groups. About 48-50 papers were presented. Included were the following: "Interaction between the coastal zone and the open sea," by Artur Svansson; "Some factors limiting primary production in the coastal waters of the southern Baltic," by Barbara Malewicz; "Eutrophication and mass production of blue-green algae in the Baltic," by Ulrich Horstmann; "Seasonal changes in the level of detergents in the brackish water of the Dead Vistula and the Bay of Gdansk," by Gerard Drewa, Zbigniew Zbytniewski, and Fryderyk Pautsch; "Efects of zooplankton abundance and temperature on time and place of reproduction of Baltic herring groups," by E. Ojaveer and M. Simm; "Fish production in the Helsinki sea area," by R. Anttila, H. Lehtonen, and Y. Valtia; "A production model of the Baltic salmon population," by Per-Olov Larsson.

These proceedings would be of interest to anyone studying the effects of pollution. Participants were from Denmark, Federal Republic of Germany, Finland, German Democratic Republic, Poland, Sweden, United Kingdom, and the United States.

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In Brief . . . .

Striped Bass Migration, Salmon Runs, and Squid Fishing

. . . .**Though striped bass migration has been accepted for many years,** recovery of a California-tagged specimen in Oregon waters has now provided "hard evidence" for the belief, the California Department of Fish and Game reports. The female striper, tagged as a 26-inch, 5-year-old 8 April 1975 on the San Joaquin River near Antioch, Calif., was found dead off Coos Bay, Oreg. by a crab fisherman on 26 September 1975. It weighed about 8 pounds and was about 29 inches long. . . .

. . . .**A long-range, space-assisted program to spot early red tide stages** has been approved by the Florida Department of Natural Resources and the National Aeronautics and Space Administration's Goddard Space Flight Center in Greenbelt, Md., the FDNR has announced. By detecting subtle color variations in coastal waters with photographic overflights and on-site sampling, changes in concentration and species of marine phytoplankton populations, especially the red tide organism, *Gymnodium breve*, might be noted. . . .

. . . .**The 21st annual meeting of Atlantic Fisheries Technologists** will be held at Newport, R. I., reports Jeffrey L. Howe, seafood technologist with the University of Rhode Island's Marine Advisory Service, and president of the organization. The URI Sea Grant Program will host the event 17-20 October 1976 at the Sheraton Islander Hotel. The conference will feature the latest developments in seafood processing technology and will be slanted toward the seafood industry. . . .

. . . .**A multi-year study of the mid-Atlantic outer continental shelf** (OCS) is being conducted by Virginia Institute of Marine Science oceanographers under sponsorship of the Bureau of Land Management, Department of Interior, VIMS reports. Information acquired will serve as benchmark data and enable future assessment of environmental conditions in the event of OCS oil and gas development. Monitored will be hydrocarbons and trace-metal levels, benthic organism and zooplankton community structures, bacteria distribution and activity, will be determined, and natural tumor rates of benthic organisms. . . .

. . . .**Good Atlantic Ocean squid fishing** was found last summer by Japan's semi-governmental Marine Fishery Resources Research Center squid vessel, the 422 GT *Hoyo Maru No. 63*. Beginning 3 June, the vessel averaged about 3.8 tons per day according to the *Suisan Keizai Shimbun*. The assigned catch target was 210 metric tons, and by 20 July the vessel had taken about 170 tons of medium-sized (18.6 cm) immature "surume" squid. Fishing was done at depths of about 200 meters. . . .

. . . .**Appointment of Maryon Brechin,** Etobicoke, Ontario, **and Robert J. Uffen,** Kingston, Ontario, **to 5-year terms on the Fisheries Research Board of Canada** has been announced by Environment Canada. Brechin is Immediate Past President of the Consumers' Association of Canada. She is also a Director of the Canadian Institute of Public Affairs. Uffen, Dean of the Faculty of Applied Science, Queen's University, is a former Chairman of the Defense Research Board, Member of the National Research Council, Chief Scientific Advisor to the Cabinet, and Dean of Science at Western University. . . .

. . . .The landlocked University of Oklahoma has received a $90,000 Sea Grant to continue its **search for marine organism extracts that might be used in treating cancer,** hypertension, and cardiovascular disease, the National Oceanic and Atmospheric Administration reports. Since 1971 the Oklahoma scientists have provided the National Cancer Institute with extracts from 1,665 marine species for testing against experimental tumor systems. Of these, 104 have been confirmed as active against leukemia in mice and 30 against human cancer cells in tissue culture. Organisms of greatest interest to the scientists include corals, sea whips, sea fans, anemones, sponges, and others low on the evolutionary ladder. . . .

. . . .**U.S. Senator Claiborne deB. Pell has received the national Sea Grant Award for 1975,** the University of Rhode Island reports. The award recognizes contributions to the understanding and utilization of ocean resources. Senator Pell, an author of the act creating the national Sea Grant College Program, was presented his award by the Sea Grant Association at its eighth annual conference in Biloxi, Miss. on 29 October 1975. Past recipients include Athelstan F. Spilhaus, special assistant to NOAA Administrator Robert M. White, Wilbert M. Chapman, Lauren R. Donaldson, Wayne H. Tody, and John A. Knauss. . . .

. . . .**The second European Ichthyological Congress will be held 8-11 September 1976 in Paris,** France, the *IMS Newsletter* reports. The scientific program is divided into four major topics (Evolution of Fishes; Zoogeography, Ecology, and Behavior; Fish and Mankind; and Ichthyology and Ichthyologists), each with a series of invited lectures and individual contributions. Further information is available from the General Secretary, J.-C. Hureau, Museum national d'Histoire naturelle, Dynamique des Populations aquatiques, 43, rue Cuvier, 75231 Paris Cedex 05 France. . . .

. . . .**The record 14,261 pink salmon returning to Alaska's Auke Creek** near Juneau in 1975 shows the feasibility of hatching salmon eggs in gravel incubation systems, according to the Department of Fish and Game. The average pink salmon run in Auke Creek before gravel incubator use was about 2,500 fish with a high of about 3,800. Runs of 4,948 fish in 1973 and 6,260 fish in 1974 were also attributed to the gravel incubation system. Average 1975 fry survival was 1.1 percent. The experimental Auke Creek hatchery was built and operated under a cooperative agreement with the National Marine Fisheries Service, the Alaska Department of Fish and Game, and Territorial Sportsmen. . . .

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